From H. K. LEWIS,
136 GOWER STREET, LONDON, W.C.
(Publisher to the New Sydenham Society).

WITH THE PUBLISHER'S COMPLIMENTS.

fol. Ed. [illegible]

THE

CAUSATION OF DISEASE

Ballantyne Press
BALLANTYNE, HANSON AND CO.
EDINBURGH AND LONDON

a

THE

CAUSATION OF DISEASE

AN EXPOSITION OF THE ULTIMATE FACTORS WHICH INDUCE IT.

BY

HARRY CAMPBELL

M.D., B.S. (LOND.)

MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS; ASSISTANT-PHYSICIAN AND PATHOLOGIST TO THE NORTH-WEST LONDON HOSPITAL

LONDON

H. K. LEWIS, 136 GOWER STREET

1889

PREFACE.

The object of this work is to trace out the ultimate causes of disease—not of particular diseases—but of disease in general.

In writing a work of this kind two courses are open to the author. One is to saturate himself with all the available literature on the subject, and, having done so, to connect into an intelligible whole the facts and opinions thus gleaned, adding, amending, and omitting as may seem fit. The other is for him to think the subject out independently from beginning to end, and to draw upon the resources of literature only just so far as apposite matter may chance to present itself in the ordinary course of his reading, or as his line of thought may from time to time suggest some special reference.

I have adopted the latter course, not, indeed, from any preconceived plan, but rather from the force of circumstances, which led me in the first instance to think out the subjects here treated of for my own personal benefit.

And, on the whole, I am inclined to think that the second of these two methods is the better; for, although the author is put to the pains of thinking out for himself questions which have already been decided, and, moreover, runs the risk of being charged with plagiarism, his work is far more likely to

bear the stamp of originality, and he escapes the very considerable danger of being a mere compiler.

While correcting the proof-sheets, I had the advantage of reading Mr. Mitchell's work on "Evolution and Dissolution," and this suggested some of the remarks on this subject contained in Chap. XII., Part I. My indebtedness to this author was, through oversight, not acknowledged in the text; but with this exception I have, I believe, in all cases acknowledged the authorities I have made use of.

H. C.

CONTENTS.

PART I.

PART II.

PART III.

THE

CAUSATION OF DISEASE.

PART I.

CHAPTER I.

GENERAL REMARKS ON CAUSATION.

SINCE the chief object of this essay is to inquire into the ultimate causes of disease, it is necessary at the outset to attach a definite meaning to the word *Cause.*

There is no subject in the whole range of philosophy which has excited greater interest than that of Causation; but this is not the place to enter fully into it. I propose, therefore, to say only just so much upon it as is needful for a philosophic treatment of the subject in hand, and my remarks on this head will furnish the keynote to the method adopted throughout this work.

Suppose the question were asked: What is the cause of gravitation? The reply would be: Gravitation is an ultimate and undecomposable property of matter—that is to say, one which cannot be simplified or referred to any wider principle behind or beyond it. It has, therefore, no cause. for cause implies an antecedent, and gravitation has, as far as we know, no antecedent.

Again, let the questions be asked: What is the cause of O uniting, or, in simpler language, *why* does O unite, with H in the proportion to form water? Why does H unite with Cl to form hydrochloric acid? Why, in short, does each

element behave in a way peculiar to itself in respect of its power to combine with other elements? The answer again is: These properties of elements are ultimate and unanalysable properties, just as gravitation is ultimate and unanalysable. Such ultimate properties—or, as we may term them, primitive causes—have, as far as we know, no beginning, and therefore we cannot say that they themselves are caused, for cause implies an antecedent, and therefore a beginning, and that which has no beginning can have no cause.

Starting, however, with these ultimate or primitive causes, we observe that an infinite variety of effects may be produced by a *modification of the material conditions;* indeed, every effect with which we are acquainted may be thus produced, whether mental or physical. What do I mean by material conditions? Under this term I include: kind of matter (O, Cl, H), quantity of matter, motion of matter (atomic, molecular, or massive); finally, disposition of matter, or, as I should be inclined to denominate it, "*structure.*"

Now, given certain material conditions, the same result will always follow. This is the Law of Causation. Man has discovered—that is to say—from long observation of Nature, that her operations are fixed and unchangeable. We do not find a certain effect follow upon certain material conditions to-day, and another effect follow upon the same conditions to-morrow. We observe, on the contrary, certain regular sequences, and these, when put into words, are called laws. Thus, none of Nature's laws are fickle and irregular, but fixed and unchangeable.

I shall then define *the cause of any particular effect* as *the sum of those material conditions from which that effect has necessarily followed.**

How far it is psychologically permissible to refer all phenomena to "material conditions," as above defined, matters

* I desire to make two remarks on this definition. First, I do not mean by "any particular result" any like result, but one particular result which has happened. The same result may follow from different causes—*e.g.*, heat—therefore in the definition I prefer to speak of one special instance. Secondly, I wish it to be understood that I use the term *sum* in the strict algebraical sense, it includes certain conditions and excludes all conditions which do not take part in, or would interfere with, the result.

little to us, so long as the conclusions deducible from this assumption shall aid us in the practical concerns of life. The physician can have nothing to say to any portion of philosophy which cannot be reconciled with utilitarianism; but, although I would gladly escape the psychological aspect of the question, it is advisable to state—very briefly—wherein the above definition of cause is psychologically deficient.

First, the definition assumes a material world, but it is utterly impossible to prove the existence of such material world, since we have no knowledge of anything but our own mental states. Of anything outside of or apart from mind, we can know nothing. Inasmuch, however, as the assumption of a material world and of material conditions, as above defined, by no means interferes with the conclusions based thereon, so far as they affect the practical conduct of daily life, we are at perfect liberty to assume the existence of a material world. I, therefore, unhesitatingly speak of material conditions, although it would be psychologically more correct to speak of phenomena —of that which seems to be (= the phenomenal) as distinguished from that which is (= the noumenal).

A second point which, from the psychological point of view, deserves notice, is that no mention is made of "Force" among the material conditions. Our conception of force is the mental ingredient out of which our conceptions of matter, space, time, and motion are built.* It will only be necessary to refer to the first two of these. Matter is ultimately known to us through its manifestations of force, through the resistance, namely, which it opposes to our muscular energies. This resistance is twofold; for, first, matter resists our efforts to push it out of position, and is capable of pushing us out of position—whence arises the idea of *repulsion;* and, secondly, it resists our efforts to rend its several parts asunder (= cohesion), and hence arises the idea of *attractive force.* We conceive of force, therefore, as something which *attracts and repels.* A little thought will show that matter can only be known to us through its manifestation of force (= resistance), for "abstract this, and nothing but empty extension remains." But, on the other hand, we cannot think of force

* *Vide* Herbert Spencer's "First Principles," § 50.

(= resistance) apart from matter; and, being thus unable to mentally separate the two, we are justified in including, under kind of matter and quantity of matter (= mass), both the matter and the force which is inseparable from it. As regards the different "kinds" of matter, this force is peculiar for each kind, since each separate kind has specific powers of attraction and repulsion.

It follows that there is no need to make specific allusion to "Force" among the material conditions above defined. It will further be observed that no mention is made of "Space," but this idea is embodied under "Disposition of Matter," which signifies the relative positions which the particles of matter occupy in space.

Out of the material conditions above enumerated all the effects within our experience can be obtained, be they physical or mental. I mean by this, that all phenomena (the word is convenient) could be referred to these material conditions, did we possess the power of analysing the conditions out of which they arise; that, in investigating the origin of any phenomenon, our search should be directed towards this end; and that, when we have discovered the material conditions out of which that phenomenon has arisen, we possess the most perfect knowledge of its causation which it is possible for us to obtain.

I say the causation of mental phenomena, alike with that of physical phenomena, can be expressed in terms of "material conditions." Whatever psychological incongruity there may appear in this, we shall find nevertheless—once more to appeal to utilitarianism—that the conclusions obtainable from this assumption are such as help us practically. What is the connection between mind and matter matters little to us, for it is now generally recognized that in every mental sequence there is a corresponding physical sequence, and that there is a close correlation between mental capacities and tendencies on the one hand, and cerebral structure on the other; so that, in dealing with causes of mental phenomena we shall still have to do with material conditions.

According to the Law of Causation the same conditions are always followed by the same result, and, while speaking of the causation of mental phenomena, it is well to remark

that there is only one exception to this law which has been advanced with any cogency—viz., the Power of the Will. It is argued by the supporters of the *Freedom of the Will*, that this faculty may act differently under exactly the same circumstances—that is to say, the motives to action remaining the same (both in respect of quality and quantity), the Will, unfettered by any rigid principle of cause and effect, is free, by a power peculiarly its own, to determine action in any given direction. It is probable, however, that the will forms no exception to the Law of Causation.

Since, then, every effect can be referred to material conditions, it follows that in studying the causes of disease our search must be directed into the material conditions out of which disease arises.

CHAPTER II.

The Causation of Gross Material Effects—The Causation of Atomic and Molecular Effects.

Let us now briefly apply the conclusions arrived at in the last chapter—first, to gross material effects; and secondly, to the more minute atomic and molecular effects. Under this latter head are included the chemical changes of protoplasm, *the sum of which constitutes life*. Having thus acquired a scientific insight into the causation of atomic and molecular phenomena, and consequently of the vital changes of protoplasm, we shall (I believe) be in a position to define the cause of disease in intelligible terms, disease being *an abnormal mode of life*.

First, as regards gross material effects: let us, in theory, construct a planetary system containing a given number of worlds, each having a definite mass and velocity, and all bearing definite relations to one another. In such a case, we are ourselves the choosers of the material conditions, and we can, from two well-known laws, calculate the resulting complex series of movements with the utmost accuracy, the two being: the law of universal gravitation and the first law of motion. These laws are simply verbal expressions of sequences which are the outcome of the ultimate properties of matter already spoken of. What then is the cause, in this hypothetical case, of the complex series of movements? It is the sum of the material conditions. Let any one of them be altered—*e.g.*, the mass of any one world—and the entire series of movements will be changed. It is very important to note that *all* the material conditions which take part in the production of a given effect constitute the cause, and not any *one* of them.

To make this point clear, let us conceive a nicely constructed

balance placed *in vacuo;* let all friction be removed, and then let us suspend from each arm a ton weight. There will be perfect equilibrium. If now, a grain weight be added to one of these ton weights, the latter, we can assert positively, will descend with a certain degree of momentum. Now, it would be vulgarly said that the particular grain is the cause of the descent, for, the two ton weights exactly balancing one another, the grain will fall to the earth as it would do if left unsupported *in vacuo;* but, as a matter of fact, every other grain in the descending ton weight takes an equal share in pulling it to the earth; and, if the slightest particle be removed from the other ton, the result, as expressed in terms of momentum, will be modified, and the same will happen if the slightest friction be added. We cannot, therefore, refer the cause of descent to any one particular grain of matter; the sum of the material conditions of our conception constitutes the cause.

Secondly, as regards atomic and molecular effects. In the above examples we are dealing with gross material conditions, with obvious and palpable matter—matter, that is, which is capable of being recognized as such by the senses. But beneath the world of our every-day life there is a world of the infinitesimal. Our senses take cognizance of quantities ranging within very narrow limits, and although the intellect can reason with vast and infinitesimal quantities, our knowledge of quantity above and below a certain narrow range is merely symbolical—that is to say, we can only represent it by symbols—it is beyond our realization. Let us remember that this difficulty of conception in respect of quantity is not confined to the immense. We are apt to forget this, unmindful of the fact that a second is split up into billions of parts by a vibration of the violet ray of the spectrum, and that the atomic particles of a protoplasmic cell may be as small in comparison with the cell as is this latter in comparison with our earth. Knowledge (I use the term advisedly, assuming that we can measure such quantities accurately) of this kind is only symbolical; but because our senses are thus limited in range, we must not turn in disdain from the subject, but rather try diligently—let the success be never so slight—to form some faint conception of these infinitesimal quantities.

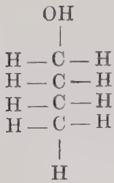
Now, according to the theory of Dalton, matter is not *continuous*, but consists of particles called atoms. This theory has been steadily gaining in strength since Dalton's time, and is now placed upon a firm basis. There are about seventy different kinds of atoms. These are united, by what is called *chemical force*, into molecules, and these latter are, in the case of solids and liquids, held together by the physical force of cohesion. I mentioned *kind* of matter as one of the material conditions which are at the root of all phenomena. The term refers to the different varieties of atoms. Each kind of atom, we must suppose, possesses certain fundamental, undecomposable properties, and these properties relate to the power which each atom possesses of attracting to itself other atoms, so as to form different kinds of molecules. It may be that all these atoms are decomposable,* all possibly consisting of different groupings of still smaller particles of only one kind of matter; and it may also be that the chemical and cohesive forces are but varieties of one force—the universal force of gravitation. Such possibilities must have occurred, I imagine, to most men who have thought carefully over this subject, but whether it be so or not—whether the atoms and these two forces be analysable or not—none of them have yet been analysed, none therefore have, logically, any cause. We must accept each as a fundamental, undecomposable fact. This remark also applies, of course, to gravity, which itself may possibly not be an ultimate property; but the possibility of any presumed ultimate property being decomposable does not prohibit the assumption of its undecomposability until the reverse is proved. It does not, that is, negative on the ground of illogical treatment, the general results arrived at.

We are now in a position to apply the definition of cause to

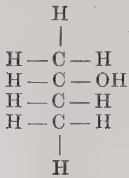
* Lockyer has put forward the hypothesis that all the elements are really compound—*i.e.*, different kinds of aggregation of one kind of matter. According to this hypothesis, the matter of which the universe is composed, was at one time equally distributed through space, and uniform in kind, although made up of atoms. These then aggregated into two's, three's, or more, and then again into "elements." This hypothesis rests upon evidence gained by observing different elements under excessively high temperatures (as of the sun) by means of the spectroscope; the spectroscopic characters suggesting decomposition of the elements into simpler bodies.—*Phil. Trans.*, 1874, p. 49 *et seq.*

chemical action. All chemical action is governed by "material conditions," and the material conditions of which chemical action is the outcome are—(1) The presence of certain kinds of atoms. (2) The arrangements of these atoms—*i.e.*, their relation one to another. (3) The kind of motion by which these atoms, and the molecules formed of them, are agitated—namely, heat, light, electricity and such like modes of motion. In seeking for the "cause" of any particular chemical change, we can do no more than discover the material conditions as just set forth. These, as Bain would say, "are the final terms of the explanation." Viewing the matter thus, we see how little is the difference between astronomy and chemistry. We must not, in our blindness, despise the tiny atom, for, in the eye of the natural philosopher, it is as important as any great world rolling through space, and, indeed, the analogies between the two are very great: both world and atom are indestructible and eternal; each is governed by fixed and unchangeable law; and, if an atom is small by the side of the world, so is a world small by the side of the universe. A group of worlds, arranged in a planetary system, is akin to a group of atoms forming a molecular system; the atom, like the world, is the seat of movements both about its own axis and about a point outside itself; finally, both the planetary and the molecular systems have a definite structure, which may be defined as the mutual positions which the constituent parts, whether worlds or atoms, bear to one another.

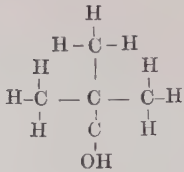
That the structure, or mutual position of the several atoms in the molecule determines very largely the nature of that molecule, is well shown in the case of the so-called isomeric bodies—that is to say, unlike bodies whose molecules contain the same number of the same kind of atoms. The primary, secondary, and tertiary alcohols afford a familiar example. These are isomeric, but each differs from the other in its chemical properties, and chemists have actually attempted to determine the molecular structure in each case. Thus:



Primary alcohol.



Secondary alcohol.



Tertiary alcohol.

Not only have the constituent elements of a planetary and of a molecular system a definite relation to one another, but *each of these smaller systems forms part of a larger system*, for each planetary system stands in definite relations to other celestial groups, and each molecular system is definitely related to the surrounding molecules.

CHAPTER III.

The Causation of the Vital Changes of Protoplasm—Definition of Structure as applied to Living Matter—Proper Method of Studying the Causation of Disease.

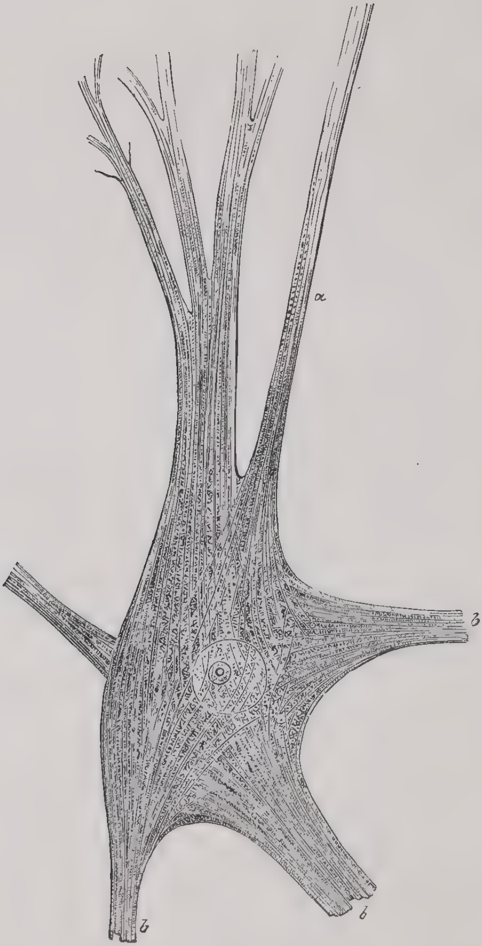
In the latter portion of the last chapter we dealt with the causation of atomic and molecular phenomena in general. Let us now treat of the causation of those atomic and molecular changes occurring within living protoplasm.

A protoplasmic cell consists of myriads of molecules, and in contemplating the structure of such a cell we must include both the mutual relations of the atomic constituents of the molecules, and the relations which these latter bear among themselves. Protoplasm is often spoken of as homogeneous. If the molecules were regularly arranged throughout the entire cell protoplasm, the latter would be in a sense homogeneous, though still possessing a structure, but we have no right to assume any such regular arrangement of molecules in protoplasm; indeed, we are *à priori* compelled to conclude otherwise. The fact that the cells of different tissues have different functions proves that their structure is different. This follows from the law of causation, but it is not possible for the most accomplished histologist to refer to its proper order every individual cell that is at haphazard given him for examination, though he may recognize them when grouped together into tissues.

When it is said that protoplasm is homogeneous, it is meant that it is a homogeneous jelly-like matter, which, however, may be moulded into various forms—that is to say, though the general configuration of the cell may differ, it is assumed that the substance of which it is built up is homogeneous. For instance, nerve ganglion cells, blood corpuscles, and kidney epithelial cells—notably some of them—are quite

unlike in gross configuration, though they are made up, it is supposed, of a homogeneous substance. This is a false supposition, and is disproved by three facts:—(1) Dr. Klein has

FIG. 1.



Ganglion Cell from anterior Horn or Cornu of Grey Matter in the Spinal Cord of a Calf. *b*, Processes abruptly broken off. *a*, The axis cylinder process. Magnified about 800 diameters. (Max Schultze.)

long proved that protoplasm contains a complex network. (2) Many cells, especially nerve-cells, show a very distinct

structure (*see* fig. 1). (3) Finally, as I have already said, differences in function are a distinct proof of differences in structure. Think, for an instant, of an impregnated ovum and of the vast potentialities locked up within it. There is little difference between the apparent structure of a human ovum and that of many belonging to the lower animals; but the fact that each develops into an entirely different being, shows what a vast difference there must be in the minute structure of each. One might be pardoned for lingering long on a subject like this. Who, possessed of any imagination, can think of the microscopic ovum-cell without feeling wonder? It appears to consist of nothing but a very slightly differentiated protoplasm; but this is simply because our senses are limited in scope, and are unable to take account of what we may, somewhat paradoxically, term the vast world of the infinitesimal. The potentialities of the ovum are the outcome of certain material conditions. In this tiny cell are aggregated billions of atoms and molecules. These are arranged in peculiar ways, and it is upon the nature of the atoms, the arrangement of the atoms into molecules, and of these latter among themselves, that the subsequent developmental changes depend—just as the complex movements of the heavenly bodies depend upon the nature (mass, &c.) of the individual heavenly bodies, the arrangement of these into planetary systems, and the relations of the planetary systems one to another. Thus we may speak of the heavens as possessing an infinitely complex structure, and thus also all analogy leads us to assume that an ovum-cell, or indeed any other mass of living protoplasm, is endowed with a structure so subtle and intricate as to be out of the reach of man's limited faculties.

I have thus far only spoken of the "structure" of individual cells; but in considering this term as applied to living matter, we must, in the case of multicellular organisms, include the relations of cell to cell—that is to say, the grouping of cells into tissues. It is in this latter sense that the term is more ordinarily employed, but it appears to me to have a wider scientific meaning: thus, I include under the word "Structure," as applied to living matter—(a) *the mutual relations of the constituent atoms in the molecules;* (b) *the relative positions*

of the molecules in the cell; (c) *finally, the relations of the cells among themselves.*

It may be thought that nothing in this or the preceding chapters has any connection with the causation of disease; but I hope that the foregoing remarks have helped us in this wise—that they have placed us in a position to define the cause of life; and it is very important that we should have clear ideas as to the causation of life, because if we cannot give an intelligible definition of life, we certainly cannot of disease, for *disease is a peculiar mode of life.*

How, then, shall we define life, and what shall we say is the cause of it? In order to answer this, let us take the simplest form of life—a unicellular organism, or simple protoplasmic cell. Such a simple cell consists of a peculiar grouping of certain kinds of atoms into molecules, and a peculiar grouping of the molecules among themselves, each grouping—the atomic and molecular—being such that, when the protoplasmic cell is placed within a certain environment—when there is, that is to say, a certain material arrangement round and about the cell, a certain interaction takes place between the cell and the cell-environment. This interaction we term *life;** it constitutes the life of the cell, and the *cause* of life, according to our definition of cause, is the *sum of the material conditions of the cell and those material conditions of cell-environment which share in the mutual interaction.*†

* By saying that life is a certain interaction of cell and cell-environment, I am, of course, not attempting a logical definition of it. After life is over a "certain interaction" occurs between the two. The above statement, although a very inadequate definition of life, is correct so *far as it goes*, and is sufficient for our purpose.

† I have here assumed that the phenomena of life may be expressed in terms of natural laws, for the peculiar interaction of cell and cell-environment, is in the last resort a chemical action, and chemistry, as we have seen, is nothing else than molecular physics. In the language of Huxley, "Life is a form or mode of ordinary force." This is now the prevailing view. A few writers, however, still cling to the old notion that life is sustained by a force which is quite unique, which cannot, namely, be correlated with ordinary chemical and physical forces. Thus Beale says: "Life is a power, force, or property of a special and peculiar kind, temporarily influencing matter and its ordinary forces, but entirely different from, and in no way correlated with, any

We must very carefully observe that the external material conditions can in no way be excluded from the field of causation. They are as necessary as the internal material conditions. In other words, the environment takes as large a share in the vital processes as the cell itself.

Life, then, being an interaction of cell and cell-environment, disease, which is a peculiar mode of life, must have a similar causation. Assuming an ideal standard of healthful life—which is easy enough to conceive but most difficult to define *—we may speak of *disease as an abnormal mode of life.* We arrive, therefore, at this important principle: all *disease depends upon either* (1) *peculiarity of cell- or tissue-structure;* (2) *peculiarity of cell-environment;* or, finally, (3) *peculiarity of both.* If a cell be perfectly fashioned as regards the kind of its component atoms, the arrangement of these into molecules, and the disposition of the latter among themselves; and, if, moreover, the environment be a fit one, the vital processes must of necessity proceed healthily. The cell is endowed with certain powers, the outcome of structure, and, like a wound-up clock, must run through its course of action. This follows from the law of causation: given the same conditions, the same results must always follow. But if, on the other hand, the cell-structure be abnormal, or if its environment be unfitted to its proper working, the vital processes will no longer go on normally: there will be, not health, but disease.

Disease, then, having two sides—(1) cell-structure, (2) cell-

other." Further, the Duke of Argyll remarks: "Let us never forget that life, as we know it here below, is the antecedent or the cause of organization, and not its product; that the peculiar combinations of matter, which are the homes and the abodes of life, are prepared and shaped under the control and guidance of that mysterious power which we know as vitality; and that no discovery of science has ever been able to reduce it to a lower level, or to identify it with any purely material force." Quatrefages speaks in a like strain: "Living beings are heavy, and therefore subject to gravitation; they are the seat of numerous and various physico-chemical phenomena. . . . . But these phenomena are under the influence of *another force* (=Life)." It is worthy of note that both of these latter authors are anti-Darwinists. This question has, I hold, been permanently set at rest by the lucid writings of Huxley.

* The question of ideal normality of structure and environment will be considered in a future chapter (Part II.).

environment—we must study its causation under two aspects. We must discover, as far as is possible to us, what are the determining factors of

(1) cell- or tissue-structure,
(2) cell-environment;

and it will be convenient to symbolize these two factors by the letters S and E respectively.

CHAPTER IV.

The Environment—The Environment of Unicellular Organisms—The Internal-Cell-Environment of Multicellular Organisms—The Primary Mal-Environment—The Secondary Mal-Environment—Remarks on the Nomenclature of Disease.

THIS and the following chapter will be devoted to the consideration of that great factor in the vital process which we may denominate "The Environment." The Environment, or to use a convenient symbol, the "E" of multicellular organisms, falls under a twofold division: into (*a*), internal-cell-E, and (*b*) external-body-E. The latter has to be divided into organic and inorganic E, and further into mental and physical E.

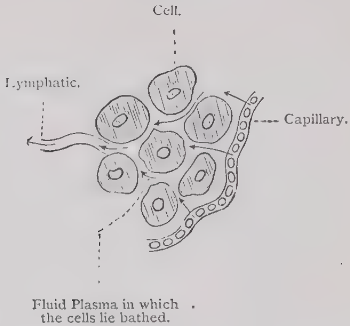
A fit E, be it carefully noted, implies certain positive conditions, and also certain negative ones. It requires, to wit, as positive conditions, particular kinds of food, water, salts, oxygen, and a particular temperature; negatively, it requires the absence of certain nocuous substances, notably, many products of cell-action. Here let me remark that the term "material conditions" embraces this *absence* of certain conditions as well as the *presence* of others; for if, to these positive conditions which are necessary to life, others be added, the material conditions will obviously not be the same. When, therefore, I speak of "certain material conditions of E necessary to healthful life," I obviously exclude such as are injurious or fatal to it, and I take no account whatever of that large range of indifferent conditions which do not affect it one way or the other—for better or for worse.

The influence of E upon cell-action is best studied in unicellular organisms. We may instance the yeast plant among numberless possible examples. This organism multiplies far more rapidly in some fluids than in others, but its

activity is checked by the products of its own cell-action—by alcohol for instance. Thus we see that the E controls cell activity, a rich food-supply hurrying on the vital process, while the presence of certain poisonous substances has the opposite effect. So much for unicellular organisms.

The Internal-Cell-Environment.—I have hitherto, for the sake of simplicity, spoken chiefly of single unit cells—for I wish to proceed from the simple to the more complex—but it is now necessary to remember that the tissues of a complex

FIG. 2.



organism consist of many such cells. Each cell is fixed in its proper place by a connecting tissue substance, and each (excepting those lying upon the surfaces) dwells in a tiny chamber, where it lies bathed in a nutrient fluid, which percolates the wall of the capillary blood-vessel, and after passing into the cell-chambers, escapes by the lymphatic vessels leading out of them. Every cell is thus, like the amœba, bathed in a nutrient fluid, from which it derives its food, and to which it returns its refuse. (See Fig. 2.)

The life of a complex organism may be defined as *the sum of all those interactions which take place between the various cells constituting the organism and their several environments.*

Much that is highly interesting and instructive might be written on the part played by individual cell-E in the processes of hypertrophy, degeneration, and development, but my remarks on this head can only be few. In treating of the factors which determine structure, I shall attempt to show how important is the *rôle* played by E. For the present I will only

briefly allude to the processes of hypertrophy and degeneration. The former is due to a modification of cell-E. Consider the case of muscle. Increased exercise leads to a larger supply of blood, the E of individual muscle-cells is thus richer in food-stuffs and Oxygen, and the cells therefore grow to their fullest limit, or may even be excited into multiplication. But what will happen if, on the contrary, their blood-supply be cut off wholly, or in part, while at the same time all agents of putrefaction be excluded? Degeneration occurs, fat taking the place of protoplasm. Again, the influence of E upon cell-action is well shown in the case of those cells which congregate in an inflamed area. If the blood-supply to them be deficient, as it often is, they degenerate into fat, and perish, and may thus (if circumstances do not permit of their removal) form cheesy masses; if, however, the E be compatible with life, they continue to live and grow. There is every possible grade—according to the nature of the E—between the extremes of rapid and complete degeneration, on the one hand, and of advanced and permanent development, on the other.

Many unicellular organisms float freely in a fluid medium from which they derive their food, and to which they return their refuse. But the component cells of complex tissues are fixed; it becomes therefore necessary to provide for them a fitting cell-environment, and to this end organs are required for the manufacture of nutrient blood-plasma for securing the proper supply of O, for conveying the fluid food and O to the tissues, and lastly, for removing the refuse matters. If any one of these systems is thrown out of gear, it is obvious that the cell-environment will be interfered with. There will cease to be that proper interaction of cell and cell-environment which constitutes health. The interaction will be abnormal. There will, in other words, be disease.

All disease is ultimately such an improper interaction of cells and their environment. We have therefore now to inquire into the several ways and means by which this cell-environment may be influenced; for disease—it is obvious from our definition of it—may come through any of them. The following list exhibits some of the ways in which cell-environments may be morbidly modified:—

1. By insufficient, excessive, or improper ingesta. The latter, of course, includes poisons, germinal or otherwise.

2. By disease of the blood-plasma-forming tissues—*i.e.*, those organs which convert the ingesta into suitable food for the cells.

3. By inhalation of insufficient O or of nocuous matters, mechanical, germinal, or gaseous; also imperfect exhalation of lung excreta. The temperature and dampness of the atmosphere may also exert an ill effect upon the body.

4. By disease of the blood-cell-forming organs.

5. By disease of the respiratory organs.

6. By disease of the vascular system: Heart, blood-vessels, and their nervous regulating systems.

7. By disease of the excretory organs: the cell sewage not being properly drained off, the cell-E contains matters injurious to life.

8. By direct nervous influence upon cells. The striking of a nervous impulse upon a cell constitutes a modification of E, since the influence comes from without. In this way the muscle dynamite is exploded, and the zymogen of the gland converted into zyme, while the direct influence of the nervous system upon cellular elements is abundantly shown in the field of pathology.

Since every tissue and system is dominated by the nervous system, we see how potently it may control the individual cell-E's. Thus the vascular, the excretory, the respiratory system, &c., are under its direct control.

These considerations should prepare us for the fact *that the nervous system plays an enormous rôle in the phenomena of disease.*

9. By injurious influence upon the exterior of the body—*e.g.*, violence, extremes of temperature, filth, parasites.

Now, if one tissue is capable of modifying the environment of another, it is obvious that disease in one tissue may set up disease in another, and this again in a third, and so on. Disease in a complex organism, such as man, is thus often a very complicated process.

All the tissues of the body are in fact knit together into one physiological whole, so that if a disease originates in any tissue

in any one of the ways just enumerated, it is apt to rapidly implicate the other tissues. Thus, a slight defect in one of the heart-valves may ultimately lead to an altered E of every cell in the body. A leakage in the mitral valves may entail a terrible series of troubles, beginning with an excessive accumulation of fluid in the cell-chambers, and leading on to a universal growth of fibrous tissue. Aortic regurgitation, too, may profoundly modify the bodily nutrition by causing the blood to flow in jerks through the capillaries, and thus interfering with the proper interchange between the intra-capillary blood and tissues. How soon does kidney disease, again, make its influence felt throughout the body! The circulation of nitrogenous sewage renders the tissues more apt to inflame; hence the tendency to bronchitis and inflammation of the serous textures. It may be that the circulation of these poisonous matters through the tissues is alone sufficient to excite inflammation, or perhaps the inflammatory process is due to their presence, *plus* something else which could not by itself provoke inflammation. Be this as it may, inflammation always occurs sooner or later. All the other complications of granular kidney are due to the retention in the blood of these same nitrogenous products. I imagine few will dispute this. The universal mal-nutrition, the disordered digestion, the enlarged left heart, the thickened, contracted and atheromatous arteries, the breaking of blood-vessels whether in the brain or elsewhere, and the paralytic stroke: these are, each and all, links in the same vicious chain. It is interesting to speculate upon the proper position of these several links, more especially so far as concerns the vascular changes, but whatever their proper place, none can doubt that they all actually are links in the same chain. None can doubt, I say, that a defect in the sewage system may so implicate the vascular system as to lead slowly but surely to a riddling of one of the cerebral vessels, to the flooding of the brain-substance with blood, and to the paralysis of one-half of the body.

In like manner a defect in the secretory system may work evil by producing a universal modification of cell-E. Suppose, for instance, a digestive juice to be faulty: blood-

plasma will be imperfectly formed, and thus every cell in the body will suffer for the error in one—it may be very limited — patch of tissue, for the fluid medium which surrounds each individual cell—at all events, all those which are engaged in active vital processes—will be defective in composition.

We thus see how potent is one tissue to modify the cell-E of others. In respect of this power, there is, however, none so far-reaching in its influence as that constituting the nervous system. Every individual system of the body is controlled by the nervous system: by it the most subtle changes in capillary blood-pressure may be brought about, and the amount of capillary blood-pressure doubtless influences the circulation of the plasma environing the cells; the nervous system again exerts a most potent control over secretion, excretion, the production of heat, and many other processes which it is needless here to enumerate. When we reflect, indeed, that every active cell in the body, such, for instance, as the gland and muscle cell, is directly supplied with a nerve filament, it becomes at once obvious what a dominant influence the nervous system wields over the rest of the body. The nerve twigs are, as it were, the reins with which the nervous system governs the body, now curbing the cell activities, now allowing them full play—nay, it may even be urging them on to some specific effort, as when the muscle inogen is exploded, the invisible muscle motion being converted into sensible motion; or when in a gland-cell the zymogen is converted into the zyme.

There is, however, one method by which the nervous system influences the cell-E of the tissues which needs a special mention. I allude to the influence of the mind. The operations of the mind, or, as some would prefer to say, "mind," may influence cell-E in two ways: (1) directly, (2) indirectly. (1) That mental states are capable of directly influencing bodily states there can be no doubt. This subject has been fully dealt with by Dr. Tuke in his classical work, and consequently needs no elucidation here. Although the direct influence of mind over body deserves to be considered under a separate head, yet, physiologically speaking, the process is in no way peculiar; it acts in the same manner as the non-mental nervous influences

—*i.e.*, through the vaso-motor system, trophic nerves, and so forth. (2) The mind indirectly affects the individual cell-E of the body through its power of regulating the external-body-E. A very large number of diseases are caused by an improper mental regulation of this external-body-E. (For the present, however, I wish to confine myself to the internal cell E; the external bodily E will require separate consideration.)

Owing to the dominant influence which the nervous system wields over the other tissues, it often happens that a disease originates in it, although this connection entirely escapes our observation. Of late years, several disorders, which the older writers would never for one moment have thought of associating with the nervous system, have been traced primarily to it, such as gout, rheumatism (?), and diabetes, not to mention Charcot's disease, perforating ulcer, rheumatoid arthritis, and such like disorders.

I do not propose to exhibit, in any further detail, the influence of the various tissues upon one another, an influence which, as we have seen, is due to the power which one tissue possesses of modifying the cell-E of another. My object has simply been to emphasize the fact.

Now, the various parts of the bodily machinery being thus closely connected, it becomes almost impossible to get one portion unhinged without throwing the entire machine out of gear, and here we may fairly ask, How far is it possible to get a strictly local disease? A disease may remain strictly local. This happens in many surgical disorders, such as a slight wound or dislocation, or a benign tumour situated in some part of the body, such as the buttock, where its influence is incapable of being reflected far and wide. It is possible, too, to get a small patch of atheroma which shall exert no remote effects. Most local diseases of this kind are, however, capable of causing more or less general trouble: an atheromatous patch may develop into an aneurism, a slight scratch may lead to tetanus or pyæmia, and a dislocation to much general discomfort. It is well to remember, moreover, that many disorders which are apparently strictly local, are not really so; thus cataract, by damaging eyesight, may lead to considerable

alteration of the external-body-E. A decayed tooth may cause neuralgia or dyspepsia, and thus, in an indirect way, bring about a universal modification of cell-E.*

Diseases, then, may be roughly classified into the general and the local, but it is difficult to draw the dividing line sharply between them, few diseases being local in the strict sense of the word. We meet, in fact, with every possible grade between a strictly local and a thoroughly general disease. Scarlatina is a typical general disease: in it rapid and profound changes are wrought throughout the body. Organic heart disease might be accounted local, at all events in its early stages, although it eventually becomes general, and, indeed, the most strictly general diseases usually begin locally—that is, in one particular tissue. Some few, however, have a more general origin, such as the specific fevers, for although the poison is commonly introduced through one particular tissue, it is rapidly disseminated throughout the body. Scurvy, too, cannot be said to originate in any particular tissue: it is really due to a universal mal-E, some essential element in the blood being absent.†

Disease, it has just been said, usually begins locally. When this is the case it is of the first importance to specify, if we can, the tissue first affected, and the nature of the E acting upon it.‡

* Supposing a condition such as atheroma or fatty tumour to be strictly local, and supposing, moreover, that it cause no trouble or inconvenience whatever to the individual, the question arises: are we justified in regarding it as disease? I have no hesitation in saying that we are not justified in regarding it as *actual disease*. If it contain within it the germ of some future mischief: if a fatty tumour be destined one day to press upon some nerve and cause pain, or if an atheromatous patch be but the germ of a future aneurism, then we have in these two diseases examples of *potential* but not *actual* diseases. We have no more right to speak of them as actual diseases than we have to assert that an individual is afflicted, in the embryo, with all those diseases which he is destined to suffer. The mere possession of obvious structural abnormality does not, in my mind, constitute actual disease.

† The use of the term "blood disease" in medical literature is very misleading, for, owing to the mutual dependence of tissue upon tissue, there are few, if any, general diseases in which the blood is not sooner or later involved.

‡ In order to complete our knowledge of causation, it would be further necessary to discover the part played by structural weakness of the affected tissue. If we can assign to E and S respectively their proper share in causation

If we are satisfied that the S of the tissue in which the morbid process starts is normal, we may for all practical purposes speak of its mal-E as the sole agent in causation. (I say for all practical purposes, for disease being an abnormal interaction of S and E, we can never logically exclude the S from causation.) This E may be spoken of as the *primary mal-environment.* As the result of this primary morbid action the E of tissues other than that primarily affected is modified, and there occurs in them also a morbid interaction of cell and cell-environment. This may be spoken of as the *secondary mal-environment.* In this way one morbid action is set up after another in tissue after tissue, and there is established a complex chain of morbid actions, which it should be our business to trace back, link by link, to its origin. We have seen that disease is a morbid interaction of cell and cell-environment, and we had then in mind a simple unicellular organism, but in a complex organism built up of many cells, disease consists of many such morbid interactions, and any given disease may be defined as *the morbid interaction of the primary mal-environment and the tissue primarily affected plus all those morbid interactions of the secondary mal-environments and the tissues secondarily affected;* the name of the disease connoting the sum of these morbid interactions.

As regards the primary mal-environment, it may be defined as that mal-environment of a tissue which is not due to disease of another tissue. It may consist of an external agent acting upon a tissue and either (1) producing disease in it, or (2) in some other tissue *through* it, *the tissue first acted upon escaping disease.* External agents setting up disease in the surface-tissues (skin and mucous membranes) afford examples of the first order. Thus are produced wounds, typhlitis, scabies, silicosis: diseases in which the action of the external agent is disseminated throughout the tissues also come more or less under this head —*e.g.*, trichinosis, tuberculosis, specific fevers—but not entirely. Pneumonia affords an example of the second kind of primary mal-environment, this disorder being sometimes brought about

we should then have the fullest explanation of causation which the case admits of. We are for the present, however, only concerned with the influence of E. The influence of S will be considered hereafter.

through the agency of a tissue (viz., the nervous) not sharing in actual diseased action. Although it is now the fashion to narrow the sphere of cold as a cause of disease, none, I imagine, deny that it is adequate to cause ordinary croupous pneumonia. This it probably does through the agency of the nervous system; the external-mal-E acting upon the nervous system of the lungs leads in them to a mal-environment, and it is a *primary* mal-environment, for we may presume that no actual disease is set up in the nervous system, though through it another tissue is morbidly affected. Some may think I have not chosen a happy example in pneumonia, and they may say the lung-trouble is a local expression of a general disorder. Be this as it may, the case, as I have put it, illustrates my meaning.

I have said that when a disease has a local beginning, it should be our business to fix upon the tissue first affected, and to trace all the resulting ill-consequences link by link. This we do by a careful study of the morbid symptoms—past and present—and of the external-body-environment. What are the symptoms of disease? They are the morbid changes which show themselves during life either subjectively to the patient, or objectively to him or to the examiner.* Yellow skin, itching, &c. &c., are symptoms of obstructive jaundice; uræmia, bronchitis, and hemiplegia, of granular kidney. All these symptoms, be it noted, are due to secondary mal-environment, and, indeed, most symptoms have a like origin. A feeling of weight and pain in the chest from the ingestion of indigestible food is apparently a symptom due to a primary mal-environment of the stomach's interior, but it is really due to a secondary mal-E in the sensorium: impulses starting in the gastric mucous membrane travel up to the sensorium, and set up in it those mysterious changes which, in psycho-physiological language, we are pleased to term the physical side of consciousness. Almost all pains—the most terrible symptoms of disease—are due to mischief outside the sensorium, for it is a curious fact that disease of the cerebral grey matter generally

* It is wise to make no distinction between signs and symptoms, for such a distinction is both useless and confusing.

causes no pain. The pain in cortical disease is probably due to involvement of the meninges—at all events, experimental injury to the cortex causes no pain. Among symptoms due to primary mal-E, the swelling of typhlitis, the eruption of scabies, and traumatic hæmorrhage may be instanced.

When in any given case of disease we have observed all the symptoms, they are to us so many marks of morbid action; and it is then our duty to put each in its proper place in the chain of morbid action. In most diseases this chain is so complex that it is often very difficult, and sometimes quite impossible, to work out the puzzle. But this should always be our aim, and we should above all endeavour, by the aid of the symptoms, to determine the primary link. When we cannot do this, we must seek for the nearest attainable. For example, a patient suffers from cerebral tumour, but presents no other symptom than hemiplegia, we cannot in such a case refer the hemiplegia to anything behind it—this is the most remote link discoverable—and, though really a symptom of something else, it is raised to the full dignity of the substantive disease. If, however, the tumour be afterwards diagnosed, the disease is no longer styled hemiplegia, but cerebral tumour; and thus, when we travel backwards, link by link, to the primordial one, the disease of to-day may become the symptom of the morrow.

*   *   *   *   *   *

This seems a fit place to say a few words on the subject of nosology. The nomenclature of disease is not based on one, but on several methods. (1) The most obtrusive symptom may be signalled out, as in scarlatina, small-pox, consumption; (2) the mal-E, if very obvious, may serve to designate the malady, as in tapeworm, sun-stroke; or (3) the disease may be named after its discoverer. This last method is probably the most objectionable of all. It would be difficult to find a common basis of nomenclature; in regard to diseases beginning locally, we should, I think, where possible, choose a term which shall not only specify the tissue primarily affected, but shall also indicate, as far as possible, the nature of the morbid process—*e.g.*, rheumatic mitral endocarditis, mammary carcinoma, puerperal peritonitis. It matters little, however,

by what word, or combination of words, we choose to designate any particular disease so long as we have a clear idea of the morbid interactions (or what is known of them) which the name chosen is intended to connote; and inasmuch as the morbid interactions are in no two cases, even of the so-called "same" disease, exactly alike, we must allow a considerable latitude to the meaning of the same term, modifying it in different cases according to our exact knowledge of the morbid process.

CHAPTER V.

The External-Body-Environment—An Analysis of it—Its Divisions into Organic, Inorganic, Mental, and Physical—The Distinction between a Diverse and Complex External-Environment—Summary of this and the preceding Chapters.

The External-Body-Environment.—The distinction which I have drawn between the internal-cell-E and the external-body-E is obvious: the one refers to the ex-corporeal material conditions which operate upon the body; the other signifies the immediate E of each individual cell.

It may be thought that the external-body-E is very simple, but this is not so, and it is highly important to understand how very varied and complex it is. The external-body-E is divided by Darwin into the inorganic and the organic. The former includes, among other things, the state of the atmosphere as to purity, temperature, dampness, and a host of telluric conditions whereof we have little or no knowledge; also the amount of sunlight and the nature and degree of muscular exercise (for when we exercise we are working against the force of gravity).

But over and above these various *inorganic* environments we have to take into account a highly complex *organic* E. Every organism is one of a community, and is brought into intimate relation with several other organisms, which therefore stand to it in the relation of external-body-E.

Thus we may divide the external E into the organic and the inorganic; but it is necessary to make still another division of this external E—viz., into the *physical* and the *mental*. This division is convenient and indeed necessary, yet each in reality falls under the same head, for the mental E operates through the physical world. All those agencies which act upon the brain and go to build up the mental world of an individual are

included under this mental E. These agencies are not immaterial: they are essentially physical. For mind can only be affected from without by impressions made upon the senses, and our sense organs are stimulated by physical forces, in a manner more or less perfectly understood—the retina by ether-waves, the ear by waves of air, the skin by a material contact more or less massive. Thus the active physical world operates upon the material brain, giving rise to a series of changes, which are the physical accompaniments of mental states. Concerning the nature of the connection between the physical and the accompanying mental chain, I say nothing. All we know, but that we know most certainly, is that while we inhabit "this muddy vesture," there is such a connection, and that for practical purposes it is both useless and unscientific to treat of mind as a separate entity; we had best regard it, with Bain, as a double-faced unity.

It is thus through a physical medium that the animate and inanimate worlds (in their purely physical aspect) affect our mental being, as when we observe the forms, colour and movements of objects, animate and inanimate, about us. Thus also are we affected by the mental world outside us—namely, are brought into communion with the minds of others, living and dead. Our mental education consists in a series of physical influences coming from without. When a boy is sent to school it is with the object of bringing such influences to bear upon his brain. His education consists in the skilful regulation of the external-mental-E. In this way his nerve centres are moulded in divers subtle ways, and thus is built up a character good or bad, and an intellectual being great or small, according to the nature of the influences brought to bear upon the individual, and the peculiar plasticity, as determined by the laws of heredity, of the nervous matter operated upon.

These observations on external-body-E render it evident that the environing influences of living organisms are not simple, but complex in the extreme. The infinite variety and complexity of the conditions which go to make up the external-body-E, can be best appreciated by bearing in mind that every separate species of plant and animal has a distinct and specific external-E; nay, more than this, it is utterly impossible, as we

shall presently see, for *any two individuals* to be surrounded by exactly the same external-E. That every species—and let us now speak of the animal kingdom only—has a specific external-E is sufficiently obvious. Each species has its own particular haunt, food, and mode of life; each stands in peculiar relations to numberless other forms of animal life. When, for instance, many animals compete for the same food, each one must include within its E all the others. This struggle is not only between species and species, but between the various members of the same species; indeed, as Darwin observes, the struggle is always greatest between members of the same species. Many animals, again, prey upon others, and thus both the preying animal and the animals preyed upon are brought into relation with one another, each therefore falling within the E of the other—and among the preying animals we must of course include the parasites. Further, the relation of animal to animal in social communities, as of the ant and bee, is very definite, and the whole remaining colony falls within the organic E of any one ant or bee. Wherefore it is very evident that every animal has a complex living E to which it must adapt itself, or it must die. The wild rabbit, for instance, has to compete against other rabbits, and many other animals in the neighbourhood living upon the same food, and has further to contend against many actual foes, such as man, foxes, stoats, and its own particular body parasites.

A consideration of the above facts renders it sufficiently obvious that the E of each species must differ considerably; and, further, that it differs for each individual of the same species, though not to the same extent. No two beings ever have been, nor can they ever be, exactly similarly circumstanced, from the beginning to the end of life.

In the case of man, the E is still more *diverse* and *complex*. By "diverse," I mean that it differs for different individuals; by "complex," that the forces operating upon the individual are not few and simple, but many and complicated. The importance of making this distinction will be evident in another part of this work. In savage communities the E of each individual is comparatively simple, and is very much the

same for all; but as we advance from barbaric to civilized peoples, the E grows more and more complex and diverse; not only, that is to say, is it more elaborate and comprehensive for each individual, but, owing to the division of labour, the E of different individuals gets very different; for just as each species of the animal kingdom has its own specific E, so likewise has each occupation. Contrast the E of the sedentary brain-toiler and of the unskilled muscular worker. The marked difference in the E of each is sufficiently attested by the different ways in which the S has become moulded in each case, for I may anticipate a part of the next chapter by observing that E is capable of working a marked effect upon S, and what a difference there will be in the S of these two individuals! In the one the muscles will be flabby, the skeleton light, the heart small, the blood-vessels thin; in the other the muscles will be firm, hard, and hypertrophied, the bones thick, the surfaces for muscular attachment rough and prominent, the heart hard, and the valves and blood-vessels thickened; in the one the higher nervous centres will be developed to the furthermost limits, while in the other they will remain very largely *in statu quo*. These are but a few of the structural differences in each case, and these differences are wrought through E. The influence of education must be said to belong to E, for, as we have seen, it essentially comes through E, and the same may be said of muscular exercise. Muscular exercise is a working against gravity, and this is essentially an external force. When the weight lifted is not part of the body itself, this is quite evident; when it consists of the body, or part of it, some of the force to be overcome lies within the body, since the latter and the earth mutually act upon one another, but the share taken by the body in producing the weight is of course infinitesimal. Indeed, the effect of use and disuse on body structure is in the last resort always an effect wrought through the external E; and I desire to lay particular stress on this fact, for I shall utilize it in support of a hypothesis to be subsequently advanced regarding the cause of natural variations. The structural difference between the sedentary scholar and the active labourer is the test and criterion of the different E in each case; and thus we have palpable evidence

of the great difference of the E of different occupations. For every occupation moulds the individual in a special and peculiar manner, so that in many instances we can say at once what is his particular calling, whether he be soldier, sailor, navvy, groom, policeman, or what not. The E of every trade or profession or calling is, in fact, different. It would be tedious to mention a tithe of them. Among manual workers there is a great difference in respect of the muscles acted upon. Thus the muscular action is different in the farm-labourer, mason, smith, miner, and the workers in the finer kinds of handicrafts; it differs both in respect of the particular muscles acted upon and as to the kind of muscular action. With some the work is long continued, with others it consists of gigantic spasmodic efforts; sometimes the individual remains stationary—standing, sitting, or even lying; sometimes he moves about, and the effect is very different in the different cases.

Again, the nature of the atmosphere differs enormously: bakers, miners, masons, and hundreds of other kinds of workers are compelled by the very nature of their calling to breathe an atmosphere laden with solid particles. Some, such as stokers, are confined in heated atmospheres, others are exposed to repeated draughts, while others, again, are much in the open air, whether on land or sea. And apart from this diversity in the physical E, there is a similar wide difference in the mental E. Each profession or calling impresses and moulds the mind in a particular way, and did we possess the proper analytic power, we should be struck with the different mental states of the members of different professions.

It is not possible to analyse the external E, mental and physical, of each of the many callings which go to build up our complex social organism; nor is it necessary, my sole wish being to bring home to the reader's mind the comprehensive nature of that which we have termed the external-body-E, and to show how infinitely complex and *diverse* it is. It is necessary to take a careful note of this *diversity*, for, as we shall see, it tends to render perfect adaptation impossible. In order to attain perfect adaptation, several generations must be exposed to an E more or less similar; but if one generation follows one occupation, and the succeeding generation

another, the adaptive process will be constantly interfered with.

We have seen that the E differs not only for different species of animals and for the different occupations of men, but that it differs also for all individuals. This is evident on the face of it, but it becomes doubly obvious when it is remembered that the E even of no two unicellular organisms is the same. Among a colony of such organisms inhabiting the same medium, it might perhaps be thought that the E would be the same for each. Nevertheless, as Herbert Spencer tells us, it is utterly impossible for any two particles of matter, no matter how microscopic, "to be similarly circumstanced in respect of the incidence of external forces." And if this be true of a unicellular organism, how much more must it be true of a being whose constituent cells are to be counted by the million?

Summary.—Here let us stop for a moment and survey our present position.

The various phenomena of Nature depend upon material conditions, as defined. The same material conditions always tend to the same results.

The material conditions of a living protoplasmic cell—which conditions are more or less perfectly embraced under the term Structure—are such, that when it is placed amid certain other material conditions, conveniently summed up under the term Environment, an inter action takes place between cell and environment. This inter-action is what we call Life, and the sum of the inter-actions between any given cell and its environment constitutes the entire life of the cell. When these inter-actions depart from a certain standard termed Health—which no man has yet been able to define, but of which our notion is sufficiently clear—we have Disease. Life, however, is still going on; disease is, then, an altered mode of life, an abnormal inter-action of S and E, depending on peculiarities in either or both. It is, as Huxley says, a branch of biology. In the complex organism, man, we depart from the simple unit-cell, and we have, instead, to deal with millions of cells, grouped into organs, and all knit into a physiological whole in such a way that any one tissue is able to modify the E of

some other, or even all the other, tissues. Disease, in such a multicellular organism, consists not of one, but of many, morbid inter-actions, both such as occur in the tissue or tissues primarily affected, and such as occur in those secondarily affected by the secondary mal-E's.

We have hitherto said nothing as to the causation of S, but have engaged ourselves with the E. We have seen that in multicellular organisms this falls under two heads: the internal and the external E, and that the latter is far more complex than appears at first sight. Space did not permit a minute analysis of the external-body-E, but enough was said to show its complexity, both in its mental and its physical side. It is with the physical E that the physician has more particularly to do. It is his business to discuss what forms of E are good for the physical well-being of man and what are hurtful, just as it is the business of those responsible for his mental welfare to seek out the good and bad forms of mental E; and it is a very happy fact that our external-body-E, both mental and physical, is very largely under our control.

If an individual have no tendency to disease—if, that is to say, his S is perfect, and if he pass from infancy to manhood under a perfect external-E—the vital processes will go forward in orderly fashion: there will be health. Given a healthy body, evil can only come through E; and indeed, as we shall see, all disease originates, on final analysis, through E, and through E alone. And just as evil can only come through E, so it is through E alone that we can exert a beneficial influence on cell-action. In practical medicine this is done by enforcing the principles of hygiene and by administering drugs. The wise physician well knows upon which he places most faith.

CHAPTER VI.

The Causation of Structure—The Two Great Causes of Structure: Heredity and Environment.

The second aspect under which we must study the Causation of Disease is that of *structure;* and this word, be it remembered, refers not only to the grouping of individual cells into tissues, but also to the individual structure of the cells themselves.

Upon what does structure depend? What, in other words, are the factors which determine the particular structure of any individual? This is the problem which now confronts us—this the question we must now answer, would we gain a philosophical insight into the Causation of Disease; for disease being a two-sided process, of which the one side is *structure* and the other *environment*, it follows that whatever affects structure may play a part in its production.

If we fix the mind on any one individual, disregarding for the time those subtle agencies which, during the long past, have moulded man into his present shape, we shall find the great determining factor to be "Heredity"—this word conveniently summing up an inconceivably complex assemblage of forces. The structure of any given individual depends chiefly, in fact, upon the structure of his more immediate progenitors. Compared with this great controlling influence, any other is small and insignificant. If an elephant could give birth to a cow, a bird to a fish, or a human being to a cat—if, in fact, the principle of Heredity were fickle and irregular—we should assign to it a minor part in shaping structure; but inasmuch as each of the many species of plant and animal gives origin to an offspring like to itself, it is evident that heredity is the great power which determines the particular structure of

an individual. It behoves us, then, to examine into the principle of heredity.

Let us first take a general glance at the process. Man multiplies by *gamogenesis*—that is to say, two separate elements, germ and sperm, enter into union, and there is gradually built up man. The whole series of changes depends, of course, upon the structure of the two elements and the nature of the E.* The case may be briefly put thus: By virtue of "heredity," the offspring tends towards a structural standard, which is a certain mean between the parental structures. Owing to the sexes, this mean is different for each—the male offspring tending towards one structural type, and the female offspring towards another structural type.

But although there is such a tendency towards a given type, peculiar to each sex, this type is, as a matter of fact, departed from, otherwise children of the same parents would be exactly alike—the male progeny on the one hand, and the female on the other. There must, then, be at work agencies interfering with "Heredity." These agencies are nothing more nor less than peculiarities of *environment*. If the E were in all cases identical —and such an identity is totally impossible—there would be a perfect likeness between the sons and between the daughters, and the likeness would be exact in every particular, even to the subtlest evolution of thought. (It is necessary to observe, however, that, inasmuch as the parents may acquire several structural peculiarities between the births of their first and last children, the parental structures are not fixed quantities, and this would tend to prevent identity among the offspring even though the E were identical. We may conveniently neglect this fact for the present.) But the E is not the same in any two cases, hence there are deviations from the standard. These deviations are called *natural variations*. The term is generally applied to such of the offspring as differ *markedly* from the immediate ancestors, but it is clear that the narrowest variation is quite as much a variation as the widest, and, inasmuch as all the children of the same parents differ, they are all natural variations from this fixed theoretical mean. It is

* See the remarks on cause. Chapters I., II., and III., Part I.

necessary to observe, however, that, even though they all exactly corresponded to the structural mean, they would still be natural variations; for, being a mean of the two parental structures, they would differ from each. But, upon ultimate analysis, it becomes evident that variations in E are the prime cause of natural variations, for, if the world were peopled afresh from two individuals, identical in all respects save in such structural peculiarities as depend upon sex, and if the E of all their descendants were identical, all men on the one hand, and all women on the other, would be exactly the same.

Now, the E may give rise to variations both compatible and incompatible with health. The former alone are usually spoken of as natural variations, but let us bear the fact carefully in mind that a disease attended by structural change (and most diseases are*) is quite as much a natural variation as an ordinary physiological variation. Shakespeare was a physiological variation. Pope was both a physiological and a pathological variation: he was a genius, but he had a crooked back.

Here let me remark that it is necessary to distinguish two classes of pathological variations. We may speak of these as the sub-pathological and the true-pathological.

Sub-pathological variations are such as render the individual prone to respond pathologically to specific forms of E, and it is very necessary to bear in mind that an otherwise perfectly healthy individual may vary in this way. This fact will be insisted upon elsewhere. Meanwhile it is sufficient to point out that an individual who responds pathologically to an E, which to the community at large is healthy, is, in a manner of speaking, a pathological variation, even although he be healthy in all other respects; and the same is true of an otherwise healthy individual who succumbs to an ordinary zymotic virus; for any individual who is incapable of doing successful battle against an average quantity of mal-environment, succumbs to the law of natural selection—is, in fact, an unfit, and, therefore, so to speak, a pathological, variation.

An individual may be said to be a *true-pathological* variation when his tissues are altered by actual disease.

* The part which structural change plays in disease will be considered in Part III.

What I particularly want to emphasize is the fact that all variations, be they pathological or physiological, fall under the one great class of natural variations, and it is by no means easy to sharply separate the two. In the true-pathological variations, however, the structural change is probably always one of dissolution.

It is clear, then, that the two great powers which determine structure are Heredity and Environment. We may thus frame two important propositions, and these together will serve as a text for this portion of our subject.

1. If "heredity" were unhampered, there would be complete identity among the male offspring born of the same parents on the one hand, and among the female on the other, each structural type being a certain mean between the parental structures.

2. This identity is destroyed by a diversity of E.

Each of these two factors, Heredity and Environment, must now be considered in greater detail. The latter thus comes in for a second consideration—this time as a power capable of influencing structure. I shall treat of them separately, so far as possible, but it will be quite impossible to keep them rigidly apart.

CHAPTER VII.

The Causation of Structure (*continued*)—Heredity—Sexual and Asexual Reproduction — Reproduction by Simple Division—Parthenogenesis—Graft Hybridism—Partial Reproduction—General Principles.

Heredity.—This term signifies a highly compounded process. Heredity is not a simple undecomposable force like gravity: a vast assemblage of forces are conveniently grouped together under the word. One day they will, doubtless, be analysed, and referred to ultimate laws, just as Newton analysed the complex movements of the heavenly bodies, showing how they were all the outcome of two simple laws—the law of gravitation and the first law of motion. Meanwhile, until this second Newton comes, we shall find it somewhat convenient to regard heredity in the vulgar way—namely, as a separate entity—as a mysterious something which moulds the offspring into the likeness of the parents. Thus I shall, to a large extent, here regard it, setting forth some of the more important facts of the process, without attempting anything further than a superficial analysis of them.

Man multiplies sexually, but there are other methods of reproduction, and it would be impossible to obtain any philosophical insight into the principle of heredity without duly considering them. All the various methods fall under two main heads—asexual and sexual.

Asexual.—The most simple variety of asexual reproduction is by simple division, such as so commonly occurs among unicellular organisms, animal and vegetable. Complex organisms, however, may be thus reproduced, as, for instance, the fresh-water worm (nais); for, if it be cut into many pieces, each will grow into the likeness of the mature organism. This method by division, and that by "budding," are essentially the same. The bud of a plant can, as we know, repro-

duce the entire organism, but other parts of the plant possess the same power; thus the smallest part of a Begonian leaf will grow into the entire plant, and, indeed, in some of the lower plants, *any single cell* is alone capable of reproducing the entire organism.

Reproduction by Parthenogenesis is really asexual, although in one sense it comes under the head of sexual reproduction. In this method the organism is reproduced by the development of an unimpregnated ovum. A partial development of the ovum takes place, independently of impregnation, even in the highest animals, in man for instance; but complete development of the ovum, independently of impregnation, has been shown to occur sometimes in certain organisms.

Reproduction by "Graft Hybridism."—This method consists in grafting one variety into the stock of another. The blending of the two tissues does not always occur, but in some rare cases it does happen. This method is, strictly speaking, asexual, but it approaches in character to sexual reproduction, since it results from the blending of the tissues of two distinct organisms—a hybrid mongrel resulting. It differs from sexual reproduction in that the blending is not of two specific portions of tissue thrown off by the reproductive organs, but of pieces of tissue chosen more or less indefinitely.

Partial Reproduction is always asexual. Broadly speaking, this power varies inversely, as the complexity of the organism. Nevertheless, some vertebrates possess it in a high degree; for instance, the tail and limbs of the same salamander have been cut off, and have regrown, eight successive times. The healing of wounds belongs, of course, to this method of partial asexual reproduction.

Sexual Reproduction is clearly allied to the above asexual method. In parthenogenesis, for instance, we have a differentiated portion of tissue, which is strictly speaking an egg, largely dependent upon impregnation for development, but capable sometimes of developing independently of such impregnation. The process is in this case analogous to reproduction by budding. Moreover, as just now observed, the hybrid in graft hybridization results from the union of the tissues of two distinct plants. Finally, in proof that sexual and asexual reproduction are

closely related, we may cite the fact that many algæ are reproduced by a process termed conjugation, in which a cell of one alga unites with that of another, the united mass growing into a separate organism.

All the highest forms of life are reproduced by the sexual method. Every naturalist must have asked himself why such union of two distinct elements is necessary for the reproduction of the higher forms of life. Now, respecting sexual reproduction, there are two conclusions to which we are easily led. First, that the whole object of sexual reproduction is to secure the union of two pieces of protoplasm *derived from separate organisms;* for it has been beautifully shown by Darwin, especially in the case of plants, that organisms containing in themselves both sexes are most cunningly supplied with appliances whereby an occasional fertilization by another organism is ensured.

Sexual reproduction, then, having for its object the union of protoplasmic masses belonging to distinct individuals, the question arises, why is this? Can we make any further generalization? Certainly we can. And this leads to the second conclusion to which I referred — namely, that the object of sexual reproduction is to secure the union of masses of protoplasm belonging to separate *unlike* organisms of the same species: if, that is to say, the separate organisms were exactly alike, reproduction would not occur. This important generalization rests upon observation. In proportion as the organisms coming into sexual union are like one another, in that same proportion is the propagation of the species rendered difficult. Perpetual breeding in and in leads to deterioration and eventual extinction of the species. But in proportion as judicious crossing between different varieties takes place, in that proportion is the stock improved. "It is," says Darwin, "a great law of Nature that all organic beings profit by an occasional cross with individuals not *closely related to them in blood*, and that, on the other hand, long-continued close inter-breeding is injurious."* Darwin adduces irrefutable evidence in proof of this. He reminds us that in this controversy the *good resulting from inter-crossing* has not been so frequently discussed as the

* "Variation under Domestication," vol. ii. p. 94 (2nd edit. revised).

evil effects of inter-breeding, which may not become manifest for a long period of time. The good effects are shown in increased constitutional vigour, while the evil results consist in diminished size and vigour, and sometimes in actual malformation. Part of the evil effect, no doubt, must be attributed (in the case of animal-organisms) to the fact that the same morbid tendencies are apt to exist in parents of near blood, which morbid tendencies thus have no chance of diminution in the offspring. But this will not account for the *diminished size* he speaks of, far less for the tendency to malformation.

It is very interesting to observe that much of the evil of inter-breeding may be mitigated if some of the stock be kept in different localities. The explanation is obvious. Differences of E work differences in the S, and thus the inter-breeding animals are rendered more unlike. We may therefore lay it down as proven that one great purpose which Nature has in view in resorting to sexual reproduction is to secure the union of protoplasmic masses derived from *unlike* organisms.* Inasmuch, therefore, as distinct advantages accrue from sexual reproduction, we can easily see how this method has become fixed by natural selection.

Can we push our reasoning farther, and answer the question: How is it that close resemblance of the organisms brought into sexual contact is inimical to proper reproduction? Darwin points out that changed conditions of life act beneficially upon an organism—we shall have occasion to allude to this interesting fact again†—and he considers that the good resulting from a cross may be due to the fact that each parent has been subjected to different conditions. He seems to think that in this way the more or less stable equilibrium of the germ and sperm is broken, and the formative forces thus initiated. Herbert Spencer's hypothesis is more elaborate than Darwin's, though in complete harmony with it. He asks the

* Intercrossing not only benefits by sustaining the vigour of a race. It further helps in this wise: "When species are rendered highly varied by changed conditions of life, the free intercrossing of the varying individuals tends to keep each form fitted for its proper place in Nature, and crossing can be effected only by sexual generation."—*Variation under Domestication*, p. 355. See also Spencer's "Principle of Biology," vol. i. § 95.

† See Part III.

question, "*Why* does gamogenesis occur?" and to this he replies, that "The approach towards general equilibrium in organisms is accompanied by an approach towards molecular equilibrium in them; and that the need for this union of sperm-cell and germ-cell is the need for overthrowing this equilibrium, and re-establishing active molecular change in the detached germ—a result which is probably effected by mixing the slightly different 'physiological units' of slightly different individuals."* It would be quite beside our purpose to discuss the question here; but I imagine that both these great philosophers are hovering near the mark, and that, although the phraseology may eventually be altered, the whole question will eventually be found to turn on "equilibrium."

We have already seen that there is no sharp dividing line between asexual and sexual reproduction. Each method is in the last resort very similar. The question now occurs, Can we make any generalization embracing the several methods of reproduction? All the facts seem to point to the conclusion that each part of an organism possesses a tendency to reproduce the whole. The twig of a plant placed in the ground will grow into the likeness of the mature organism. A single cell taken from the leaf of the Begonian plant will reproduce the plant; wherefore in this plant the power of reproduction belongs impartially to every part of the organism, and the same is true of very many of the lower forms of plant life. The like tendency is observed in the animal world, for if the hydra be divided into several pieces, each will grow up into a separate and entire organism. As the scale of structural complexity in the animal world is ascended, however—that is to say, as the process of division of labour proceeds, and groups of cells become "specialized" for some one particular function, this power wanes—individual cells gradually losing the power of producing the entire organism, and the power of reproduction is confined to cells which have not undergone this specialization—viz., to those formed by the ovary and testicle. This is the view taken by Herbert Spencer. Here are his exact words:—

"The marvellous phenomena initiated by the meeting of sperm-cell and germ-cell, naturally suggest the conception of some quite

* "The Induction of Biology," § 92, vol. i.

special and peculiar properties possessed by these cells. It seems obvious that this mysterious power which they display, of originating a new and complex organism, distinguishes them in the broadest way from portions of organic substance in general. Nevertheless, the more we study the evidence, the more is the assumption shaken—the more are we led towards the conclusion, that these cells have not been made by some unusual elaboration, fundamentally different from all other cells. The first fact which points to this conclusion, is the fact recently dwelt upon, that in many plants and inferior animals, a small fragment of tissue that is but little differentiated, is capable of developing into the form of the organism from which it was taken. Conclusive proof obliged us to admit, that the component units of organisms, have inherent powers of arranging themselves into the forms of the organism to which they belong. And if to these component units, ... such powers must be conceded—if, under fit conditions, and when not much specialized, they manifest such powers in a way as marked as that in which the contents of sperm-cells and germ-cells manifest them ; then, it becomes clear that the properties of sperm-cells are not so peculiar as we are apt to assume. Again, the organs for preparing sperm-cells and germ-cells, have none of the speciality of structure which might be looked for, did sperm-cells and germ-cells need endowing with properties essentially unlike those of other organic agents. On the contrary, these reproductive centres proceed from tissues that are characterized by their low organization."

He then proceeds to exemplify this statement in the case of plants and animals :—

"The embryo cells are formed in the undifferentiated part of the cambium-layer ; the pollen grains are formed at the little-differentiated extremities of the stamens ; and both are homologous with simple epithelial-cells. Among many inferior animals devoid of special reproductive organs, such as the Hydra, the ova and spermatozoa originate in the layer of indifferent tissue that lies between the endoderm and ectoderm ; that is, they consist of portions of the least specialized substance. And in the higher animals these same generative agents appear to be merely modified epithelial cells—cells not remarkable for their complexity of structure, but rather for their simplicity."

He next remarks that undifferentiated epithelial cells are often observed to exhibit the like property. Thus, referring to a certain plant, he learns from Dr. Hooker that " many young plants

are developed by a single scale" of the leaf or stem; and finally he observes that sperm- and germ-cells "differ from the rest mainly in not having undergone modifications such as those by which the rest are adapted to particular functions."*

Finally, the question occurs: How comes it that a single cell, or the union of two cells, is able to reproduce the entire organism? Darwin and Spencer have started hypotheses of a kindred character. The hypothesis of the former goes by the name of *Pangenesis*. It is now universally admitted that all organisms consists of *cells*, and that the latter are themselves separate, and more or less independent organisms. Each cell Darwin supposes to throw off tiny particles, or *gemmules*, which are capable of reproducing the particular cells from which they are derived, and he accounts for the various methods of asexual reproduction by supposing these gemmules to be scattered throughout the body. Thus, when the entire tree grows from a small twig, it is because that twig contains gemmules derived from each separate cell in the entire plant; and in a similar way he would explain the development into entire animals of each of the many fragments into which a Hydra may be divided. The re-growth of an amputated limb he considers to be "the same process partially carried out." In organisms which are reproduced sexually, these gemmules are supposed to aggregate themselves into the sexual elements—in the case of man, namely, into the ovum and spermatozoon. Suppose, for instance, an organism to consist of homogenous, gelatinous matter, then a small part separated from the rest would be able to reproduce the whole. But if the upper, central, and lower portions of the organism be of different textures, each would have to throw off a different kind of gemmule, and these, "when aggregated by mutual affinity, would form either buds or sexual elements." There is no difficulty in allowing this origin of gemmules from all the many cells of an organism, but it is more difficult to understand why the gemmules should aggregate themselves in proper order, why, for example, in the case of germ and sperm, the countless gemmules for brain, liver, lung, and other tissues, should be arranged according to a definite plan. Darwin assumes a certain "elective affinity," in

* "Principles of Biology," vol. i. § 77.

virtue of which the developing cells attract to themselves the proper gemmules, and in regard to this he says: "There are no doubt ten thousand of Compositæ, and if the pollen of all of them were placed on the stigma of a particular species this would elect 'with unerring certainty' its proper pollen" It is this second half of Darwin's hypothesis wherein the great difficulty lies. Whether his way of putting the matter is really an *explanation* is doubtful; but there is no doubt that from the beginning to the end of development the proper aggregation of molecules is the result of affinities, and that these are the outcome of material conditions.

Herbert Spencer's doctrine is somewhat similar to Darwin's. He, however, substitutes his "physiological units" for the gemmules of Darwin.*

Wherefore we may sum up the main facts of reproduction in the four following propositions:—

1. Every cell of an organism has a tendency to reproduce the whole organism.

2. This power diminishes as specialization proceeds, becoming more and more confined to special cells.

3. The cells capable of reproducing the entire organism may consist of aggregated "gemmules," or "physiological units" (using these terms in the sense their respective authors attach to them).

4. The object of sexual reproduction is to secure the union of reproductive cells from unlike organisms, so as to disturb the equilibrium into which such reproductive cells tend to fall.

Now, without further indulging in speculation, it is evident, whether this, that, or the other hypothesis be correct, that the whole mystery of reproduction or heredity hinges upon the *structure* of the reproductive cell or cells. The difficulty lies in the question—What determines the structure of the reproductive element? For, given a definite structure of germ and sperm, there is no difficulty—I, at all events, see none—in explaining, on the principle of causation already enunciated, the development of the mature organism from them. When the

* For a complete exposition of Darwin's doctrine of Pangenesis, see "Variation under Domestication," vol. ii. chap. xxviii. See also Herbert Spencer's "Principles of Biology," vol. i. chap. iv. and viii.

two come into contact, a series of associated changes ensue, which are the outcome of the "material conditions" as represented by the structure of germ and sperm, and the nature of their environment. Each successive change in the material conditions occurring during the development of the embryo is the cause of those changes immediately succeeding—just as the material conditions of a planetary system at any one moment are the cause of the changes immediately following, this new material state being again the cause of the succeeding changes, and so on to the end of time. Life, like the movements of the planetary systems, is a simple rhythm—a perpetually recurring cycle—*the last changes in the cycle provoking the first*. This, I take it, is the explanation of all rhythms.

The analogy I have drawn between the cycles of the heavenly bodies and of living beings seems to me a just one, although there is one great difference. In the case of growing organic beings matter is being continually added to the living systems, but this does not happen in the case of the planetary systems. I cannot, however, afford the space to discuss this matter here, and must content myself with stating my belief that the two processes are, upon ultimate analysis, of a similar nature, and that, given a definite structure of reproductive cells, of germ and sperm, for instance, there is no difficulty in accounting for the embryonic changes resulting from their union. The whole difficulty, as I have said, hinges upon the cause of the *structure* of the reproductive cells. How do these elements come by their structure? Therein lies the difficulty. That germ and sperm do possess a structure, and that an exceedingly complex one, there can be no doubt. But here we are brought face to face with the world of the infinitesimal, where our senses fail us. Relying only upon these, we pronounce protoplasm to be homogeneous and structureless; whereas reason urges to a different conclusion, and in its light the tiny homogeneous flecks of protoplasm, with their infinite potentialities, become two vast and complex worlds—two microcosms, in fact. It were as possible for man to develop out of glass as out of homogeneous jelly!

CHAPTER VIII.

The Causation of Structure (*continued*)—Heredity—The Grand Rhythm of Life—Minor Vital Rhythms.

Rhythms.—The subject of cycles, or rhythms, is a very important one, and it is necessary to take here some account of it, for not only is life itself a rhythm, but the animal organism is the seat of very many and diverse rhythmical processes—minor rhythms within the great vital rhythm—and it is because we are now treating of the great vital rhythm as determined by heredity that it is proper to allude to the subject of rhythm here. To treat of it in full detail would be beyond the scope of this work; for a short but comprehensive article upon it the reader is referred to Herbert Spencer's "First Principles," chap. x.

All motion is characterized by rhythm. "This is an inevitable corollary of the persistence of Force;" more than this it is unnecessary to say as to the causation of rhythm. No matter what motion we examine we shall find it rhythmical, be it the movement of an atom or of a world; and there is every degree of rapidity. The rhythm of the violet ray of the spectrum occupies less than the 700 billionth part of a second, while some of the rhythms of the heavenly bodies extend over thousands, nay, even millions, of years. Turn where we may, we find all movements rhythmical,—heat, light, sound, electricity, vital phenomena, even social changes.

As regards the minor rhythms occurring within the great vital rhythm, some of these occur in response to rhythms in the external-body-E, others independently of such external rhythm. The body rhythms due to the rhythmical changes of our planetary system afford the best examples of the former. Thus day and night impress important rhythms upon plants and animals. The rhythmically

altering E causes rhythmical alterations of functions. This is what determines the rhythm of sleep and the peculiar rhythm of temperature, noticeable in man, at all events. In those parts of the world where the rhythm of day and night is absent altogether, the inhabitants are wont to take their sleep in snatches, and we may be quite sure that there is considerable difference between them and ourselves in respect of many of the bodily rhythms. It would be very interesting to make physiological observations as regards temperature, &c., among the inhabitants of such countries, for the rhythm of day and night also determines many others in our bodies—*e.g.*, the hours of our meals, and therefore of the important processes of digestion and absorption—processes whose influences are felt through the entire body; it also determines, or should do, a rhythmical emptying of the rectum, and perhaps even of the bladder.

Now, it is interesting to note that the subjection of our body to this rhythmically altering E leads to rhythmically recurring changes, even after we cease to continue the rhythmical practices. In other words, we can educate the body to go through rhythmical changes. These we may term *rhythmical habits*. Thus man can educate himself to feel sleepy at a definite hour at night; to wake at a particular time in the morning, and that too—note well—no matter what hour he goes to bed, thus showing that the awakening is not necessarily due to mere satiation in the matter of sleep. He can further educate himself to wake at a certain hour in the night, in order to pass water or what not, and, in this regard, it is worthy of note—I have observed this many times—that if an individual perchance wake up one night to pass water, there is a great likelihood that he will do so two or three nights in succession. A man can further educate himself (and for the matter of that, many of the lower animals can also be taught) to defecate at a certain hour, always after breakfast, for instance, and so exacting is this rhythm, that very often if the individual do not go to stool at the proper time, if he delay an hour, or perhaps even half-hour, he will fail to have a motion. We can further educate ourselves to feel hungry at particular hours. "Yes," it may be retorted, "because the last meal is digested, and the tissues are

crying out for more." This, no doubt, is one element in the causation of the recurring hunger, but the sensation tends to return at the wonted hour altogether independently of the time of the previous meal, nay, even though the customary previous meal has been omitted; moreover, the sensation of hunger will often disappear if the meal be not taken at the proper hour, just as the sleepiness at the wonted bedtime may pass off if the individual, through force of will or through necessity, keep himself awake beyond this time. A girl of fifteen, for instance, sits up for several nights in succession with her mother; at the usual bedtime the heaviness of sleep comes over her, but it quite passes off after she has struggled against it for half an hour or so. The same principle applies to the practice of smoking. A man, accustomed to smoke at a particular hour, will experience the desire to indulge his habit at that particular hour, and generally at that hour only. Now all the above phenomena are due to rhythmical changes impressed upon the system by subjecting the body to certain other rhythmical changes. Each and all are distinct rhythms, the interval being, for the most part, twenty-four hours. Thus, in the case of the ordinary sleep rhythm, at the end of each twenty-four hours the body passes through a particular change. The molecules of the brain, namely, fall into a material state which expresses itself psychically as a desire for sleep. In like manner the digestive organs and that part of the sensorium which has to do with appetite are thrown into rhythmical change, and hence the rhythmical desire for food.

So much for the bodily rhythms connected with the daily rotation of the earth on its axis. The yearly movement of the earth round the sun leads in like manner to rhythmical organic changes. These are especially noticeable in the plant world, but they are likewise very marked among animals. Thus, many animals change their abode at stated seasons. A large number, again, hybernate. In others, marked dermal changes take place at particular seasons, such as the casting of the shell in certain crustacea, the shedding of the horns and of the coat in many quadrupeds, and the moulting of birds—not to mention the extraordinary tegumental changes which take place in a large number of animals during the season of sexual activity.

Is there any evidence that a rhythm depending upon the seasons takes place in man? It is, *à priori*, highly improbable that man should be exempt from a principle which operated so palpably in his not very remote ancestors. I believe Dr. Laycock was the first to teach that the skin exhibits distinct peculiarities at the different seasons. It seems to be generally acknowledged that the sexual instinct is most active during the spring time, and owing to the close connection between the sexual and cutaneous systems, one would expect to find a peculiar condition of the skin in the spring, and such undoubtably is the case.

Dr. Creighton Brown* says "it is certain that the seasons have still a powerful hold upon the human organism. There is a gain of body weight in winter and a loss in summer, and vital statistics show that each season has diseases which may be called peculiarly its own," and he alludes to the excitement of the nervous system which occurs at the time of spring, quoting the lines of Tennyson—

> "In the Spring a livelier iris brightens on the wing of dove;
> In the Spring a young man's fancy lightly turns to thoughts of love."

At this time of the year nervous diseases abound—crime and insanity increase; "crimes against the person are most numerous in spring and early summer, when the stags' horns are budding and his aggressive instincts are most pronounced; while crime against property are most numerous in autumn and summer, when squirrels lay by their stores." And in this connection it would be interesting to discover at what period of the year rape is most frequent. Creighton Brown further observes that many children in springtime exhibit "a restlessness and excitability, a perversity and irascibility of temper, or a listlessness and indisposition to exertion that are not displayed at other times."

Now, it may be thought that these organic rhythms are entirely due to the yearly rhythm in the external-body-E; it is, however, very probable that they tend to occur independently of this external rhythm, seeing that a structure may be educated

* Article, Education and the Nervous System: "The Book of Health," London, p. 315.

to pass spontaneously through rhythmical changes, by being repeatedly subjected to a rhythmically recurring E.

Are there any rhythmical changes in man answering to the rhythmical movements of the moon round the earth? It is difficult to say. I have heard people wonder at the curious fact that the ordinary menstrual rhythm coincides, as regards the length of the rhythm, with the monthly lunar cycle. If, however, the two were in any way causally related, one would expect menstruation to recur at the same time in every woman, but it does not. In one passage, Darwin vaguely alludes to the influence of the lunar rhythm on man. He points out that it distinctly influences many aquatic animals through its influences upon the tides, and he obscurely hints that man may have faintly inherited the rhythmical impress from some far off aquatic ancestor.

When a rhythm is once established it tends to go on indefinitely; one would therefore marvel that the menstrual rhythm should cease, as it is supposed to do, during pregnancy and at the menopause. Probably, however, this does not occur. Throughout the whole of pregnancy the monthly rhythm goes on. I have satisfied myself that this is so from observation,* though there is probably no ripening of an ovum, nor is there loss of blood, unless it be exceptionally. It is recognized that the uterus undergoes muscular contraction throughout the whole term of gestation (indeed, such rhythmic contractions have been regarded as an absolute sign of pregnancy), but they are palpably increased at the time when the period would have occurred, were the woman not pregnant. These monthly contractions are related to the ordinary menstrual contractions, for at the menstrual epochs the uterus undergoes considerable muscular contraction; and it is to the latter, I take it, that the pain of menstruation is chiefly due. At all events, Dr. J. Matthews Duncan, probably the greatest authority on the subject, teaches that the chief form of dysmenorrhœa is spasmodic; the

* Laycock maintained that the menstrual change took place during pregnancy. He observes, "it is singular that this doctrine maintained by the ancients should have fallen into neglect. Aetius expressly states, 'circa consueta purgationis menstruæ tempora aggravantur prægnantes et mammæ intumescunt lumbi difficulter moventur, vesica rubens et ignitum lotium excernit.'" —LAYCOCK, *Nervous Diseases of Women*, p. 46.

woman, in fact, suffering from uterine colic. This rhythmical contraction is beautifully displayed at the time of labour, which occurs at the tenth month (lunar) of gestation. Labour is, therefore, the ordinary monthly rhythmical contraction, exaggerated by the presence of the fœtus, which, about this time, owing to a combination of circumstances needless to discuss, begins to act as a foreign body. In like manner the suppressed monthly rhythm occurs during the months of lactation, though it is for the most part entirely overlooked by the woman. In regard to the post-menstrual period of life: for the first few years perhaps all women experience some monthly symptoms, and a large number will acknowledge this, if asked; but the rhythm, in all probability, continues for many years to come. I am, indeed, not at all sure that it ceases before death. Upon very careful inquiry, evidence of post-climacteric menstrual rhythm can be obtained, in a fair sprinkling of cases, up to sixty, but I have distinctly traced the rhythm past seventy. The woman will complain of backache, or flushes, or a curious headache, or she will grow dark under the eyes; and sometimes the symptoms are highly interesting, and not infrequently different to those she was wont to experience when the periods were actually upon her. Although by far the larger proportion of women—at all events, among hospital and infirmary patients—will deny any monthly indication after sixty, yet I imagine that this is due to the fact that they do not themselves recognize the rhythm, although they actually experience it.

Does the male sex undergo any monthly rhythm, akin to menstruation? This question cannot at present be scientifically answered, but it is worthy of investigation, although, perhaps, to many, such a supposition may appear fanciful. I have known several cases of disease, which have exhibited a monthly rhythm. They have mostly been nervous cases. One medical man, who suffered from monthly migraine, was in the habit of speaking of them as his "monthlies;" and I have met with a case of monthly-bleeding piles in an elderly gentleman; and it is a very interesting fact that, when, at the age of sixty-six, the hæmorrhagic flux became irregular, this gentleman experienced many of the symptoms which women complain of at the climacteric—he became emotional, and, among other things,

suffered from very marked flushings, headache, and backache, and a symptom which I have never yet found absent among those menopausic patients who seek medical relief—*soreness of the scalp.*

These remarks on rhythm would be out of place here, did they not bear upon disease and its causation. Diseases themselves are very frequently rhythmical, such as asthma, migraine, angina, ague, remittent fevers, and a host of minor nervous disorders, which have no name, but which are numerous enough to the careful observer. For it requires the greatest care, patience, and tact, to get the proper history from a patient; and I have not the slightest doubt there are hundreds of important, though *simple*, diagnostic signs, which have hitherto escaped our notice.

I have already pointed out the analogy between the rhythms of the heavenly bodies, the grand rhythm of life, and the minor rhythms displayed by living beings. Many other forms of minor rhythm might be cited, such as the rhythm of the heart and respiration, and other physiological rhythms, but I must content myself with merely stating the fact; for the rhythms of the body are, in fact, innumerable. Muscle and nerve action, for instance, are distinctly rhythmical; what is apparently a continuous muscle-contraction is made up, as we know, of a series of individual contractions (= tetanus); and even the most seemingly continuous sensation is really rhythmical. "An apparently unbroken mental state is in truth traversed by a number of minor states, in which various other sensations and perceptions are rapidly presented and disappear."

I wish now briefly to point out a further analogy between these several rhythms. Every planetary system, like every organism, has an *environment*, which consists in the universe outside; and this E reacts upon the planetary system (just as the E of a living organism acts upon *it*), and may cause modifications of planetary structure, as we may term it, which may be transmitted to succeeding cycles, or, as we may call them, planetary offspring. I have already said that E is the great cause of *natural variations;* indeed, as we have already seen, it is in the last resort the only cause. We may therefore speak of the changes in planetary structure thus effected from without as examples of "natural variation" in an astronomical organism.

Examples might be multiplied *ad lib.* to show that all the vital rhythms exhibit a similar tendency to natural variation. In order to make this clear, we must separate in imagination —and this is quite admissible—the tissue, or tissues, especially engaged in the rhythm. Let S stand for such tissue or tissues; then be it observed that under a given environment, which must include both the external and internal environment, the rhythm will steadily continue to recur, and, if only the material conditions represented by S and E remain the same, the rhythm will recur with undeviating regularity until the end of time. But these material conditions will not remain the same. In the first place, the S is continually altering as life advances—through infancy, childhood, youth, maturity, and old age. In the second place—and it is on this that I wish especially to lay stress—the external-body-environment is no constant factor, and this irregular external-E, reacting upon the S, will tend to modify it, and with it the rhythmical phenomena, which will thus vary; and this alteration, or natural variation, will tend to be inherited by the next rhythm. Thus, to speak only of pathological processes, we know that rhythmical neuralgias and asthmas are apt to vary from one attack to another; any peculiarity which has been impressed upon the asthmatic paroxysm, by peculiarity of climate or otherwise, will tend to reappear in the next attack. Who that has read Darwin can fail to be struck by the following passages: "If asthma is relegated to unchanging external influences, its cycle of phenomena will go on repeatedly, with a marvellous exactness, but the maintenance of this unvarying repetition is strictly dependent on the maintenance of identical external conditions, and any change, however trifling, is capable of breaking the existing habit, and of introducing fresh phenomena."* Again: "Any peculiarity that has once been acquired, (although, perhaps, from some transient accidental circumstance), will, as the time comes round, recur, and thus be formally adopted among the symptoms, and become a constituent part of the clinical phenomena. There are hardly any circumstances of the disease, that may not thus be lost and acquired."†

* "On Asthma" (Salter), chap. iv. † *Ibid.*

CHAPTER IX.

Causation of Structure (*continued*)—Heredity at Corresponding Ages—Heredity at Corresponding Seasons—Sexual Heredity—Some Comparisons between Man and Woman.

HAVING thus briefly touched upon the important subject of vital rhythms, we must now pass in review some of the special facts of heredity. I shall first consider the principle of heredity at corresponding ages; next, sexual heredity. I shall then allude to the principle of, what I shall term, "structural mean." Whether or not I am right in saying that the offspring tend towards a certain structural mean between the two parents, which mean would never be departed from, were they all exposed to exactly the same E, we shall, I think, find this to be a very good working hypothesis. While dealing with this blending of the two parental tendencies into a certain mean, I shall naturally be led to speak of pathological and physiological blendings—that is to say, of the blending in the offspring of certain tendencies derived from the parents: of disease tendencies with other disease tendencies, or with physiological peculiarities; and under this head it will be convenient to touch briefly upon the subject of crossing. I shall next consider the "fixity of structural characters"—namely, the degree of tenacity with which they cling to a race from generation to generation, or, when acquired by an individual, the fixity of the acquisition in the individual himself. The principle of reversion will next come in for consideration. This subject will suggest a few remarks on potentiality. I shall then notice the influence of the male element upon the female, and finally, the inheritance of acquired characters.

I. **Heredity at Corresponding Ages.**—The fact that the developmental and other changes occur at the same rate in the offspring as in the parents, leads to the reproduction of similar

tissue-structure, and therefore similar disease tendencies, or actual disease, at corresponding ages. The S varying with the age, the effect of E upon it will likewise vary at different periods of life, and hence the tendency to disease will vary too. In some cases there seems to be a tendency towards inheritance, not at the corresponding age, but at an earlier age, in the offspring than in the parent. This often happens, for instance, in gout; and Darwin points out that, when the rule is departed from, the inherited peculiarity appears earlier rather than later, for he says, "the exceptions in the other direction are very rare." The facts of embryology certainly bear out this observation.*

We may also speak of an *heredity at corresponding seasons;* for, as we have seen, there is an annual organic cycle corresponding to the annual cycle in the E. We may instance the horns of the stag, which appear at certain seasons, or indeed, the skin appendages of most animals, such as the feathers of birds, the fur or hair of animals, the scales of fish, which undergo periodic changes at different seasons. These changes are, as we have seen, ultimately dependent upon the seasons; but they come to be very largely inherited, so that, although the alteration of the seasons is necessary to show them in their most typical form, they would tend to appear independently of the seasons, through the force of inheritance pure and simple. It is probable that the same kind of skin changes occur in man. This would account, in some measure, for the especial prevalence of certain skin diseases at particular periods of the

* When an inherited character appears earlier in the offspring than in the parents, we have an example of "precocity." One of the most interesting instances of precocity is the occurrence of puberty before the wonted time. There is a fair number of such cases on record. I have now under observation a boy, who, at the age of two years, attained full sexual maturity. His testicles and penis are fully developed; there is abundance of hair on the pubes, his voice is gruff, and his muscles stand out boldly like those of a well-grown man. The sexual instinct is strong and troublesome. All will agree that this case is abnormal and unfortunate; but when a similar precocity is exhibited in other directions, the parents are often apt to regard the individual as a prodigy, as a wonder of whom great things must be expected. I refer especially to cases of premature cerebral development. No doubt, in certain cases, this promise of youth is an earnest of a great future, but, as a general rule, precocity is abnormal—a thing altogether to be regretted, whether of the brain or of the reproductive system.

year. And what is true of the skin is true also of other organs—notably, of the sexual. These, it is well known, undergo marked changes at certain seasons in many of the lower animals, and, as we have already seen, there is a faint tendency to such a periodicity in man. How far the other organs in man partake of this periodic change, it is impossible to tell; yet who can say that such hidden rhythmical changes may not largely help to determine the prevalence of certain disorders at particular seasons of the year, even though it be readily acknowledged that alteration of E at the different seasons plays the largest share in determining such prevalence?

II. **Sexual Heredity.**—When only one individual is concerned in procreation, as in the case of all asexual organisms, the principle of heredity may be put thus: The offspring tends to pass through the same series of changes, and at the same rate as the parents, the rhythms being in fact like all others. Inasmuch, however, as in the case of man, two individuals take part in the process, the offspring tends to be neither exactly like the one nor the other, but a certain mean of the two. This mean is interfered with by the structural peculiarities of each sex, for each has peculiarities connected with the difference of sexual function. But although these peculiarities chiefly relate to the sexual function, they are not confined to it, as we shall presently see.

The various sexual differences have been undoubtedly acquired during the course of ages, under the different conditions (E) to which each sex has been exposed. This subject has been carefully worked out by Darwin, who has shown that a character acquired by one sex at one particular period of life tends, in the offspring, to appear in the same sex and at the same period of life. Illustrations of this fact abound in the animal world. Thus, the antlers of the stag attain their full strength when sexual maturity is reached. At this time many males compete for the female, and success depends upon the strength and prowess of the competitors. The horns are powerful weapons, and thus a stag with strong antlers would have an advantage over another having weaker ones, and would be more likely to succeed in the struggle for the female, and to leave

offspring which would tend to inherit his peculiarities. In this way, by accumulation from generation to generation, the antlers of the stag have attained their present dimensions. And the same is true of countless other sexual peculiarities, which enable the male to secure the female.

Darwin has further shown that characters acquired by one sex at an early period of life—before the time of sexual activity—tend to be transmitted to either sex alike; but that characters appearing in one sex during the period of sexual activity tend to be inherited by that sex alone. He further points out that new characters tend to attach themselves by preference to the male sex.* These facts have an undoubted application to pathology, for we find that diseases attack the two sexes with much greater impartiality during childhood than in the period of sexual life; and perhaps the same is true, though in a far less degree, of the period of post-sexual life. This tendency of special structural characteristics to be transmitted along either sex, may be termed the principle of "sexual heredity." But such sexual heredity is not confined to sexual differences. It holds good universally—that is to say, any character whatever, when acquired by one sex, be it physiological or pathological, tends in the offspring to appear in the same sex. Many diseases illustrate this truth. Thus, gout is acquired by the male at a particular period of life, and tends to appear in the male descendants at the same age.

Mr. Sedgewick has published some interesting papers on "The Influence of Sex in Limiting Hereditary Transmission,"† and amongst other cases he records several of congenital abnormities—such as an abnormal number of fingers or phalanges—descending along the one sexual line.

Concerning this tendency for structural peculiarities to appear in one sex only, of successive generations, be it carefully noted that the peculiarity may pass *potentially through the opposite sex.* Thus A suffers from gout: his sons will be apt to inherit the complaint, and his sons' sons; the daughters, on the other hand, will tend to escape, but their sons will be liable

* "Descent of Man," second edition, p. 32.

† *Medico-Chirurgical Review*, April and July 1863.

to contract the disorder. (It is, of course, understood that in all such cases of inherited disease it is a peculiarity of structure which is inherited.)

I say the peculiarity passes *potentially through the opposite sex.* This means that the possibility of it exists in this sex, but that it is, in some way or other, kept under and prevented from showing itself. This subject of potentiality is highly interesting. Man is a compound of many potentialities, and we can never know what strange property he may show, if only the fitting conditions for its development occur. A large number of such potentialities are inherited from remote ancestors, but this subject will be best considered under the head of reversion. At present we are occupied with sexual heredity, and the tendency of structural potentialities to pass through one particular sex. The special sexual characters of each sex lie dormant in the opposite sex, for if the ovaries or testicles be atrophied, diseased, or removed, the characters of the opposite sex develop. Thus, an old duck has been known to acquire the plumage of the drake; and "a hen, which had ceased laying . . . . assumed the plumage, voice, spurs, and warlike disposition of the cock; when opposed to the enemy she would erect her hackles and show fight. Thus every character, even to the instinct and manner of fighting, must have lain dormant in the hen as long as her ovaria continued to act."* Again, the influence of the menopause on woman is very striking: the body is then apt to undergo marked change, and the mental alteration is one affording the psychologist an interesting study. The opposite condition—viz., disease, atrophy, or removal of the testicles—has a like effect, that is to say, the male tends to approach in character to the female. Now these facts show most strikingly how characters can pass latently through one sex, and manifest themselves in the opposite sex in the offspring—how, for instance, it is possible for a good milking cow to transmit her good qualities through her male offspring to future generations."† But they further explain those cases of non-sexual characters which are

* "Animals and Plants under Domestication," vol. ii. p. 36.

† *Ibid.*, p. 27. Darwin's remarks on this head deserve careful study.

transmitted along one sex only.* The potentialities are evidently kept in abeyance by some restraining influence, upon the removal of which they are ever ready to spring into existence.

If we are not careful to bear in mind that a character may pass potentially through one sex, we shall have some difficulty in comprehending aright the doctrine of sexual heredity, and apparent exceptions will frequently meet us. It is often said, for instance, that certain peculiarities pass—not from father to son, or from mother to daughter—but from father to daughter, and from mother to son. Take the case of intellectual capacity: it is vulgarly thought that this passes from the mother to the son rather than from the father. Doubtless, mental ability often comes *through* the mother, just as gout may, and sundry other characters; but it may also come from the father's side.

Indeed, this very instance of hereditary ability illustrates and strengthens the doctrine of sexual heredity. Through untold ages the mental E of the two sexes has differed. The man has had to use his brain the most, and it has been the fashion to stifle the intellectuality of the woman; there are, indeed, many men now-a-days who regard an intellectual woman with aversion. Hence, the smaller head of the woman—I speak of averages—and correspondingly smaller mental capacity. The old-fashioned plan of dwarfing the woman's

* In the "Proceedings of the Zoological Society," December 1886, Mr. Bland Sutton advances an hypothesis to account for this latency of male sexual characters in the female. He alludes to the fact that the secondary sexual characters are chiefly in connection with the skin, and this, no doubt, in the case of many lower animals, is in a large measure correct. Now, the skin is developed from the epiblast, and in Mr. Sutton's opinion, founded on observation, the epiblast is chiefly derived from the male element, the hypoblast and greater part of the mesoblast from the female. The non-development of those male (epiblastic) sexual characters in the female is due, according to Mr. Sutton, to the large demands made upon the rest of the economy, by the female generative system. This hypothesis affords no explanation of the larger and more comprehensive problem, "What determines the sexes?" nor does it explain how non-sexual characters—altogether independent of the epiblast—such, for instance, as the deformities I have alluded to, may pass along one sex only. This latter fact alone is strong evidence against the tenability of his hypothesis. It, moreover, takes no account of the fact, that the male contains the potentialities of the female.

mental and bodily activities, by not allowing her—on the ground that it is unwomanish—to give mind and muscle the full play they crave, is as foolish as it is cruel. It lays the foundation of miserable hysterias and dyspepsias, and tends to produce a narrowness and bigotry of mind which, to a thinking being, is intolerable. To suppose that a high degree of mental education would injuriously affect the generative system is fallacious. Why should it in woman any more than in man? It may happen if a delicate girl be subjected to high mental pressure; the capacity for nursing children, namely, or even fertility, may possibly be diminished. But no education should be under high mental pressure. All proper mental education is under no pressure at all. One single important fact, learnt easily, gains a hold on the mind, and does more good than 10,000 facts forcibly crammed into the brain. If the special interest of the pupil be awakened, he or she will remember the facts taught, even though dull to the very brink of idiocy; and if a child cannot understand a thing, how foolish to attempt to make it! What terrible piece of blindness, ay, and of cruelty, to teach Euclid and intricate grammar at so young an age as is the custom. The child is mentally akin to the savage, in whom the power of abstract thought is scarcely developed at all, and before this power is evolved we are attempting to draw upon it—forcing the young mind as we would a hothouse plant. But the human mind is something subtler than a vegetable, and will have none of it. No doubt mental evolution is far more rapid in some than in others, and the most precocious have all the advantage at school. They are called sharp and clever, and are made much of, whilst a more backward playfellow is accounted dull, even perhaps obstinate; and in consequence receives sundry cuffs from his master; and yet when the angry pedagogue sleeps—forgotten—this dull and stupid boy is, perhaps, adding a chapter to the history of his country.

In touching upon the subject of education, I ought, perhaps, to speak nearer home. What about medical education? I hold it to be equally defective. I do not mean as regards quantity, but method. Think of the atrocious nonsense the poor medical student has to get up for physiology—

the ridiculous theories, which, starting, as he does, in utter ignorance of the subject, the poor lad is unable to see in all their naked absurdity. But what happens? He acquires a morbid thirst for them, and while cramming himself with this trash, he is apt to make one slight error—to entirely lose sight of the fact that he is supposed to be studying *Physiology.* Every principle of physiology, as known and proven, could be put down within a very narrow compass: I am not talking of isolated and disconnected facts which, as such, are not embodied in the science of physiology, but of facts which have been intelligibly connected into principles. These main principles should be taught thoroughly, and nothing else. The student should know something about blood-pressure, which he does not, and something about the nervous paths in brain and cord, of which he is equally ignorant. But it may be argued, and I have no doubt *will* be, that this worrying out of complex theories is good intellectual exercise. Yes, but so is studying a disease at the bedside! It is surely more important to know the treatment of iritis, than the size and weight of a red corpuscle. Yet the one is as easy to learn as the other. It is surely more important to know how to treat the alimentary canal in the child, than to be acquainted with the complex chemistry of digestion. Yet brand-new practitioners are yearly turned out by the hundred who know nothing at all about these subjects. It may be said, "These things can be learned in practice." But are they always so learned? Certainly by some, but not by all; and, even when thus learned, at what expense to the patients! Think what great good can be done by the knowledge of a few simple facts which could be, but often enough are not, taught at hospitals; and let us remember that, as the vessel is launched so will it sail. An important fact, properly taught, clings to the memory with wonderful tenacity, and it is surprising what good fruit it will yield through the course of a long life. Without the knowledge of such a fact, a man may go on blundering in ignorance, for many years, allowing much abateable suffering to go on unrelieved, or, perhaps, even adding to his patient's misery. This may very easily be done in some diseases, as, for example, those of the eye—and behold the strange incon-

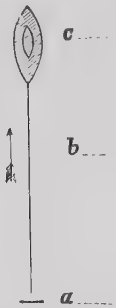
gruity—one man inflicting an injury upon another, and demanding a reward in return! But is the blame of this iniquity to be laid solely at the door of the practitioner, and are those who regulate our system of medical education wholly to escape censure?

Before I wind up this digression, I cannot resist briefly alluding to an opinion occasionally expressed—probably by men chiefly—that woman is a vastly inferior animal to man. I have heard this conviction stated by a number of men, and these by no means woman-haters. The whole question turns upon the meaning of *superior* and *inferior*. Inferior as regards what? There can be no doubt that man for man, and woman for woman, men are stronger in muscle and intellect. But muscle and intellect do not exhaust the capacities of mankind, and it is incorrect to suppose that the inferiority of the woman is a necessary outcome of a uterus, as some seem to think, many holding that this organ necessarily implies inferiority. No doubt the uterus indirectly leads to the inferiorities of woman, both in muscular and intellectual strength, but such differences as obtain between the two sexes in these respects can very largely be accounted for on the principles of (a) *use and disuse*, (b) *sexual heredity*. Women are intellectually and muscularly weaker because they use mind and muscles less. So far as the muscular system is concerned, it is well known that in those countries where women do manual labour, they can equal or even surpass the men in strength of muscle. Quite lately a medical journal recorded the case of a pitbrow woman who wagered that she would lift as heavy a shovelful of coals as any man in the mine; and among many animals the female is the muscular equal of the male. Indeed, in some cases, the female is infinitely the stronger, as in a certain kind of spider, which is so much more powerful than the male, that it is common for many males to perish in the attempt to effect sexual connection; the successful animal owing his success rather to his wariness in taking the female off her guard than to greater strength of body. The like is true of intellectual capacity. So far as I know, there is no proof that this is greater in the male sex among the lower animals, and there appears to be no reason why the generative organs in the woman should make a

greater demand upon the rest of the body than an excessive muscular system in the man.

Woman will always be more emotional than man. The emotions are grounded on the feelings, or, to speak more precisely, on the sensations,* and these latter originate in impressions made upon peripheral nerve-terminations. Let *c* (Fig. 3)

FIG. 3.



be a cortical sensory centre ; *b*, its sensory nerve ; *a*, the peripheral nerve-termination. An impression upon *a* causes a nerve impulse to pass up *b*, and this striking upon *c* brings about a series of molecular changes. The "material conditions" of *c* represent the physical side of a sensation, and, so far as it is possible to define the cause of a sensation, *they* are the cause of such sensation. What may be the exact connection between the material conditions, as represented by *c*, and the resulting mental state, it is not for us here to inquire. It is enough to state the simple fact that the peculiar material state of *c* is accompanied by the mental state. This is the "explanation" of all sensations : *a* is, as it were, the keyboard, *c* the pipe (or series of pipes) of an organ. An impression upon the keynote calls forth sound from the pipe, just as an impression upon a sensory nerve-termination calls forth sensation from its sensory centre. The animal body contains myriads of such sensory peripheral nerve-endings, and corresponding cortical centres. Impulses are continually streaming up these sensory nerves

* The feelings include the simple sensations, and the emotions. These latter are founded upon the sensations, more especially the organic sensations.

to the cortical centres, and thus striking, as it were, a voluminous chord of feeling (see Fig. 4). It is this which gives

FIG. 4.

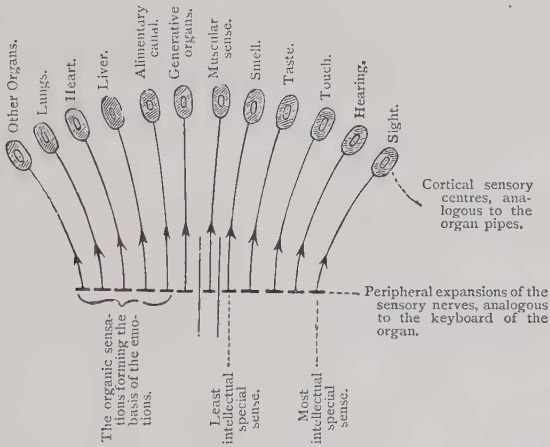


Diagram showing the different sensory system. To the right are the intellectual senses in the order of their intellectual value. These all give information of the outer world. The muscular sense occupies a peculiar and independent position. To the left are the organic sense-systems.

rise to the sense of existence—to the feeling "*I am*." The sensations of sight and hearing, and, in a lesser degree, of taste, are essentially the intellectual sensations, those, namely, which give us accurate information of the world without, which we can remember best, and between minute differences in which we can discriminate most accurately. The organic sensations of the muscles,* viscera, and, to a large degree, of touch, are more voluminous; our memory of them is also less; we have, further, only a small power of discriminating between minute shades of difference in these sensations, and (excepting touch sensations) they give us no information concerning the outer world. It is on these voluminous and non-intellectual sensations that the emotions are grounded. The accompanying diagrams are intended to show the mode in which sensations are produced.

* These must be carefully distinguished from the "muscular sense" or power of estimating the degree of muscular contraction. This plays a very important part in intellectual processes.

Among the different sensory systems (of stomach, lungs, heart, reproductive organs, &c., see Fig. 4) which take part in the

FIG. 5.

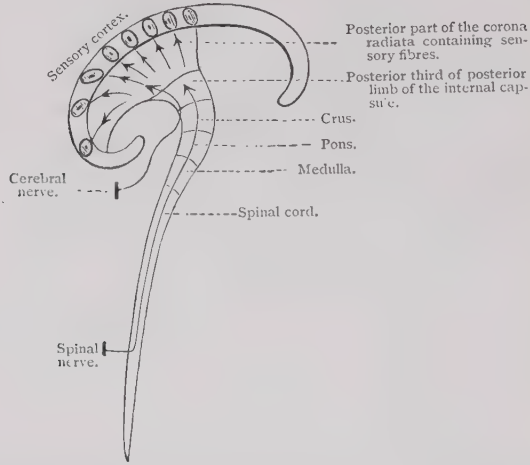


Diagram showing the sensory system of nerves passing up towards and terminating in the cortex.

production of the non-intellectual sensations, the reproductory is certainly second to none. Indeed, it very probably stands

FIG. 6.

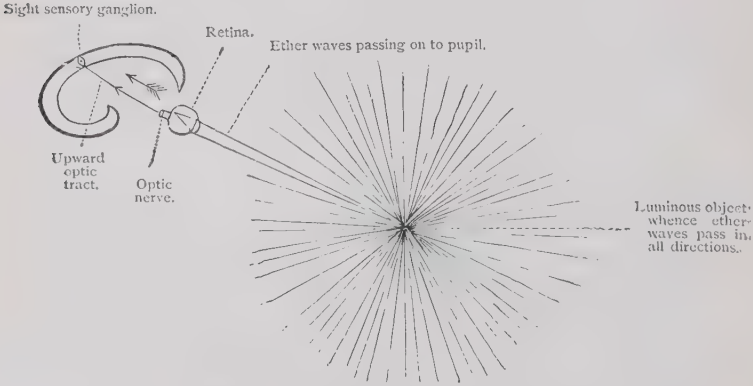


Diagram showing how the sight sensory system is thrown into activity by ether waves.

first during the period of reproductive life. It is well known that at the time of puberty a marked change comes over the

FIG. 7.

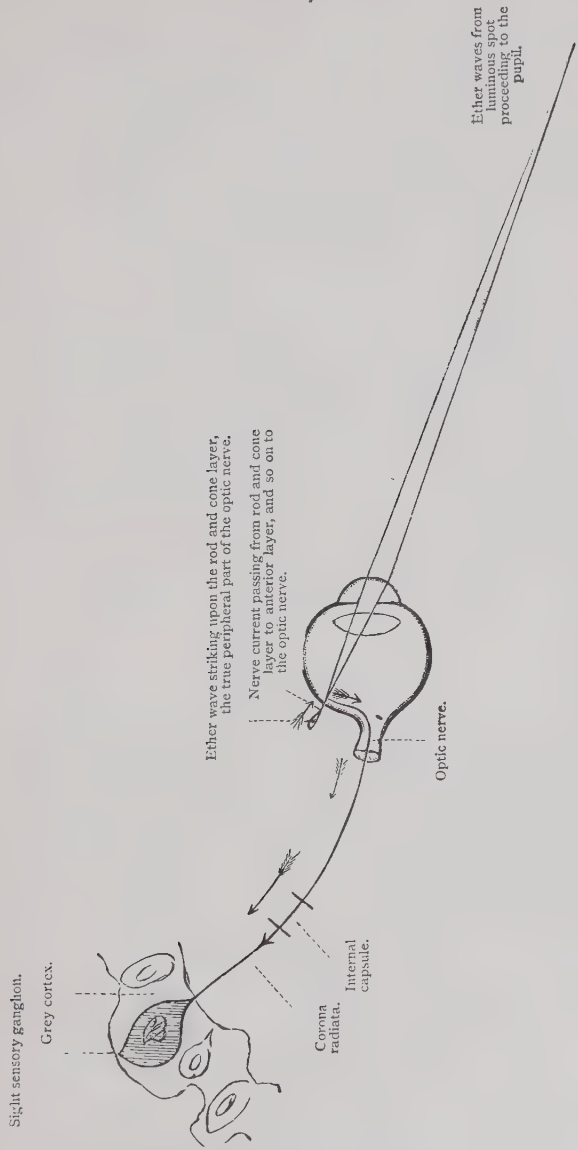


Diagram similar to the last.

feelings. This is especially marked in the girl. With the development of ovaries, uterus, and mammæ, an extensive and highly irritable sensory surface is added to the nervous system, and a corresponding development occurs in the sensory cortex. *A new keyboard and a fresh series of pipes have been added to the instrument;* consequently additional chords can now be struck, and effects produced which were before impossible.

The reproductive system is far more extensive in the female than in the male, for not only has the woman to prepare the ovum—an effort which in itself involves far more sensory disturbance than the manufacture and discharge of semen (which practically sums up man's share in the reproductive process), as is evidenced by the wide and varied sensations which are apt to accompany menstruation—but she has also to support the child nine months within her body; and for the same, or even longer, period of extra-uterine life. The effect of pregnancy and parturition on the feelings is even observed in many of the lower animals.

Wherefore it is obvious that woman must have more feeling than man, and must needs be more emotional. It is also manifest that the sexual calls upon the woman must necessarily handicap her in the intellectual race. If a woman does not marry she will be capable of greater intellectual exertion than if she does, and the brain will grow accordingly; but this will not affect future generations. We must, therefore, conclude that mental differences will ever exist between the sexes.

The intellectual difference is, I repeat, solely due to disuse. I cannot believe, as some do, that high intellectual development in woman is incompatible with proper child-bearing. If we can adduce one single example of a highly intellectual woman who has healthily reared children, such a case once and for all puts this question at rest. I doubt not many such could be given. That of Mary Somerville at once occurs to me. If there is one department of mental activity which, above all others, requires sheer intellect, it is surely mathematics. Now, Mary Somerville was one of the greatest mathematicians our country has produced; but she was also a woman of essentially feminine parts, and the devoted mother of several healthy children.

One proof of the necessary and *à priori* inferiority of the

woman's mind lies, it has been argued, in the fact that few women excel in the arts: music, poetry, painting. Surely, it is said, woman ought to excel in these, since they rest so largely on the feelings, and the fact that she does not shows conclusively that she is necessarily inferior in mind. It is perfectly true that we have no woman Shakspeare, Mozart, or Raphael; but to suppose that such men succeed without intellect is to show a complete ignorance of the meaning of the word. No man can be great as these men were without colossal intellect. Hear what Carlyle says on this head:—

"Hero, Prophet, Poet,—many different names in different times and places do we give to Great Men; according to the varieties we note in them, according to the sphere in which they have displayed themselves! . . . . The Hero can be Poet, Prophet, King, Priest, or what you will, according to the kind of world he find himself born into. I confess I have no notion of a truly great man that could not be all sorts of men. The Poet who could merely sit on a chair and compose stanzas, would never make a stanza worth much. He could not sing the heroic warrior unless he himself were at least a Heroic warrior too. I fancy there is in him the Politician, the Thinker, Legislator, Philosopher;—in one or the other degree he could have been all these, he is all, all . . . . Napoleon has words within him that are like Austerlitz Battles. Louis Fourteenth's Marshals are a kind of poetical men withal; the things Turenne says are full of sagacity and geniality; like sayings of Samuel Johnson. The great heart, the clear deep-seeing eye: there it lies; no man whatever, in what province soever, can prosper at all without these. Petrarch and Boccaccio did diplomatic messages, it seems, quite well: one can easily believe it; they had done things a little harder than these! Burns, a gifted song-writer, might have made a still better Mirabeau. Shakespeare,—one knows not what *he* could not have made, in the supreme degree.

"True, there are aptitudes of Nature too. Nature does not make all great men, more than all other men in the self-same mould. Varieties of aptitude doubtless; but infinitely more of circumstance (= E). . . . . Given your Hero, is he to become Conqueror, King, Poet?" &c. &c.

In considering the differences, mental and physical, between the two sexes—and a knowledge of such difference is very

necessary to the medical man—we must ever keep clearly in mind this doctrine of sexual heredity. This principle shows us that many of the differences between the sexes depend upon use and disuse, and are not *necessary* differences. Hence it would be possible to cancel, to a greater or less extent, many of the sexual differences; the exceedingly irritable nervous system of woman, for instance, might be rendered more stable by judicious bringing-up during many successive generations.

George Eliot recognized the principle of sexual heredity,—the fact that a peculiarity passes potentially through the sex in which it does not appear; for in "Middlemarch" she makes Mr. Brooke say: "I had it myself—that love of knowledge . . . . though that sort of thing does not often run in the female line; *or it runs underground, like the rivers in Greece*—it comes out in the sons."

Although the characters acquired by one sex tend in the offspring to appear more especially in the same sex, we should err in concluding that the other sex is wholly unaffected. Were such the case, the daughters of a man who had persistently, from youth upward, abused his health, would in no wise suffer from the father's transgressions. Whether, however, in such cases of parental transgression the male offspring necessarily suffer most, I cannot say, but the question is certainly worthy of investigation.

Are there any special conditions favourable to the strict limitation to one sex of an inherited structural peculiarity? We have already seen that one necessary condition is the acquisition of the peculiarity during the period of sexual life. A further favourable circumstance is the operation *during many generations upon one sex only* of the E tending to produce the peculiarity. Finally, I think it probable that when the tissue specifically acted upon is more or less limited, the resulting change is more apt to be confined to the sex in which it is acquired—one would expect, namely, that a strictly local modification of tissue (although this must to some extent modify other tissues by altering the E) would be more apt to be sexually limited than one more general.

This view may be rendered clearer by stating the converse case. When the entire organism is affected for good or evil, one would expect the good or evil effect to be more impartially inherited

by the two sexes than when the acquired structural change is strictly local. In such a disease as chronic gout, one would therefore expect the female progeny to be more or less affected, because, although two of the above conditions are fulfilled—namely, (1) the operation of the specific E upon one sex for many generations, (2) its operation during the sexual period of life—nevertheless the third condition is absent—to wit, strict localization of the acquired structural change; for in chronic gout, although the primarily erring tissue may be strictly local, the tissues are more or less universally depraved. But if we suppose a gout-producing E to affect a limited set of tissues in the male throughout countless generations without causing any general depravity of health—which, however, is impossible—we might predict, with a fair measure of certainty, that the affection would appear chiefly, if not solely, in the males—the female line escaping. In a similar way the antlers of the stag have been acquired; but it is worthy of note that rudimentary antlers also appear in the female, showing that the hereditary transmission is not entirely confined to the one sexual line.

Wherefore the doctrine of sexual heredity may be thus enunciated: *the more exclusively a specific E acts upon one sex, the greater the number of generations acted upon, and the more limited the affected tissue, the more apt is the resulting variation to pick out that one sex in the offspring. Moreover, a character is more apt to be transmitted along one sex when it is acquired during the period of sexual activity, and it is probably more apt to attach itself to the male than to the female sex. Nevertheless, in all cases there is a tendency for the opposite sex to be affected.*

From the above observations on sexual heredity, it is manifest that sex influences structure. It may thus be a predisposing cause of disease. Sex may further predispose to disease in so far as it determines occupation, and therefore the external-body-E, mental and physical.

The influence of sex in determining the heredity of particular diseases is a subject still requiring careful investigation. Patient and laborious statistical work is needed to clear up many points on which we are still ignorant. Meanwhile, however, much error may be averted by keeping this principle of sexual heredity clearly before us. Ignorance of it is continually leading to wrong conclusions.

CHAPTER X.

Heredity (*continued*)—The Principle of Structural Mean—Pre-potency—Physiological and Pathological Blendings.

The Principle of Structural Mean.—This has already been defined. Inasmuch as two individuals are engaged in the reproductive process, the offspring cannot be exactly like either of them, but must, on the contrary, be some sort of mean between the two. There is probably an ideal or standard mean which they all tend to apprcach, but this is subject of course to such differences as depend upon the principle of sexual heredity, so that the case will be more accurately put thus: The male offspring all tend toward a certain fixed standard, the female offspring to a certain other fixed standard.

Whatever differences occur between brothers on the one hand, and sisters on the other, are due to differences of the E, which, as we shall see, has a considerable power in altering S. This will be more particularly shown in treating of E as a power capable of modifying structure, and we shall then be the better able to understand how utterly impossible it is for the E to be anything like the same in any two cases. Such differences in E must inevitably cause corresponding differences among the brothers on the one hand, and among the sisters on the other. The only point about which there can be any doubt is whether this is the *sole* cause of the difference. I contend that it is.

It will be observed that the above hypothesis assumes an ideal, standard E. It is obviously impossible to scientifically define such an ideal; but in reality all that is necessary is to assume one. The hypothesis is rendered sufficiently clear by the statement that all the male progeny on the one hand, and all the female on the other, would be exactly alike under the same E.

It must not be thought that the structural mean of which I am speaking is an exact mean of the two parental structures.

It often happens that there is a "pre-potency" of some characteristic or characteristics of one of the parents in the offspring.

"When individuals belonging to the same family, but distinct enough to be recognized, or when two well-marked races, or two species are crossed, the usual result . . . . is, that the offspring in the first generation are intermediate between the two parents, or resemble one parent in one part and the other parent in another part. But this is by no means the invariable rule; for in many cases it is found that certain individuals, races, and species, are preponent in transmitting their likeness. . . . . It would appear that in certain families some one ancestor, and after him others of the same family, have had great power in transmitting their likeness through the male line; for we cannot otherwise understand how the same features should so often be transmitted after marriages with many females, as in the case of the Austrian emperors; and so it was, according to Niebuhr, with the mental qualities of certain Roman families. The famous bull, Favourite, is believed to have had a preponent influence on the short-horned race. It has also been observed with English race-horses, that certain mares have generally transmitted their own character, whilst other mares of equally pure blood have allowed the character of the sire to prevail. A famous black greyhound, Bedlamite, as I hear from Mr. C. M. Brown, 'invariably got all his puppies black, no matter what was the colour of the bitch;' but then Bedlamite has a preponderance of black in his blood, both on the sire and dam's side."—*Variation under Domestication*, vol. ii. p. 40.

Again, Quatrefages writes:—

"After having attributed a prepondering action to the mother, Nott declares with surprise that in point of intelligence the mulatto (negro and white) approaches in character to his white father." * He goes on to observe that Lislet Geoffrey, though entirely a negro physically, was in character and intelligence entirely a white.

The above quotations on pre-potency seem to invalidate my remarks on the structural mean. Be it noted, however, I am careful to say a *certain mean*, and not the *exact mean*. From the time the ovum and spermatozoon meet, until development is complete, or perhaps even later than this, there is a struggle between two tendencies: the tendencies of the ovum will gain

* International Science Series, Quatrefages, p. 268.

the upper hand in some respects; those of the male element in others: the final result being a structural product which is a certain mean between the two. I am contending that this particular mean, whether it takes chiefly after the male or the female parent, would not be departed from if the E were in each case the same. What it is that specially determines this "prepotency" is a difficult matter to decide, but I shall return to this question presently.*

The principle of structural mean applies equally, of course, to normal and abnormal structures, and has therefore an important bearing upon disease, for it opens up the question: what will be the effect upon the offspring of the union of a healthy with an unhealthy individual, or the union of two unhealthy individuals, having either the same or different diseases or disease tendencies? And this leads us to the interesting subject of hybridization or mongrelization of disease.

Viewed from the pathological standpoint, these blendings fall under three heads:—

1. Physiological blendings.
2. The blending of normal with abnormal.
3. The blending of abnormal with abnormal.

1 and 3 admit of subdivision into three classes. I should observe, however, that such division, though logical, is perhaps too mechanical to serve a practical purpose. We may, nevertheless, I think, adopt it provisionally. These subdivisions are—

a. Blendings of the same peculiarities of the same tissue.
b. Blending of different peculiarities of the same tissue.
c. Blending of different peculiarities of different tissues.

Thus—

1*a*. Here the blending characters are normal, of the same kind, and affect the same tissue. Thus, father and mother may have great strength of limb, strong digestion, genius for music or art.

1*b*. The blending characters are normal, affect the same tissues, but are of unlike kind. Father has taste for poetry, mother for mathematics. Father large hands, mother small hands.

1*c*. The blending characters are normal, but unlike, and

* *Vide* Chapters XI. and XII.

affect different tissues. Father remarkable for muscular strength, mother for intellect. In one sense this comes under the last head (1*b*), for there is a blending of remarkable with ordinary muscular strength, and a blending of remarkable with ordinary intellectual powers.

2*b*. One of the blending characters is normal, the other abnormal, and they affect the same tissue. The mother is emmetropic, the father hypermetropic. All abnormal blendings resulting from the union of a healthy with an unhealthy parent are of this kind.

3*a*. The blending characters are abnormal, of the same kind, and involve the same tissues. The father and mother are gouty, rheumatic, neurotic, or what not.

3*b*. The blendings are abnormal, affect the same tissue, but are of unlike kind. Thus the father is myopic, the mother hypermetropic. The father suffers from a tendency to eczema, the mother to psoriasis. In such a case one would theoretically expect a hybrid or mongrel disease to result.

3*c*. The blending characters are abnormal, but unlike, and affect different tissues. Thus the father is gouty, the mother epileptic—the father rheumatic, the mother phthisical. Here, again, the possibility of hybridization arises.

It will be necessary now to consider these classes more in detail.

1*a*. *Like physiological blending of the same tissue.*—Here, of course, the offspring will tend to inherit the peculiarity in undiminished vigour—as when, for instance, both sides of the house are remarkable for strength of muscle. In such a case there is no reason why the offspring should be muscularly weaker than the parents; nor is there any reason why they should be stronger—why, namely, there should be any intensification of the peculiarity, although one is rather apt to assume such an intensification.

1*b*. *The blending of unlike normal characters affecting the same tissue.*—If each parent present a different physiological peculiarity of the same tissue, one would expect the blending

of them to give a more or less exact mean; but here the complicated question of pre-potency comes in. If the father's nose be aquiline, that of the mother being retroussée, one would rather expect the nose in the offspring to be some sort of mongrelized product of the two. But this is not necessarily the case: either kind of nose may be inherited unchanged. It is well known, as already mentioned, how tenaciously an aquiline nose will cling to a family. Why such a character should be pre-potent it is difficult to say. Possibly one element in causation may be the ancestral age of the prepotent character. One would expect a character which had constantly belonged to a race for many generations to have a greater propagating power than one recently acquired. I imagine, for instance, that in the mulatto (half white and half negro) the flattened nose of the negro, which has belonged to the race for thousands of generations, would gain the ascendency. I only mention this influence of ancestral age as one possible element in the causation of pre-potency.

It sometimes happens, however, that unlike blendings of the same tissue give a compound quite unlike the two elements, just as the compound of two chemical elements may be quite unlike either of them. Who can say, for instance, what will be the exact result of two peculiar mental blendings; the diversity among mental characters is so enormous, and the nature of the acting forces so subtle, that we can well understand how their several blendings may yield mental traits whose parentage we are quite unable to trace. The like is true of other properties. Now, in such cases it may be said that the product is not inherited; nor is it in the sense that the *same* peculiarity is inherited, but strictly speaking it is inherited, inasmuch as each element is derived from the parents.

The coming together of unlike physiological characters of the same tissue may give a curious result—one which is in no sense a *blending*—and may similarly lead us to suppose that the character resulting from their union is not inherited, though such is actually the case. If, namely, the two characters be of recent ancestral acquisition, it may happen that they are dropped in the offspring, which lapses to a *status quo ante* the acquisition of these characters. This reversion, for such it is, does not occur

if the characters are in the same direction, but only when they are unlike. These unlike characters refuse to combine, and the offspring inherits a structural condition belonging to an ancestral period antecedent to the acquisition of such character. This subject will be considered again hereafter.

These considerations show how difficult it is to foretell what will be the result of the union of unlike physiological characters. For, first, one of the combining elements may be pre-potent; or the two may fuse into a more or less exact mechanical mean (as in the case of features, size, &c.); or again, the resulting compound may be unlike either component element; finally, the two characters may refuse to blend altogether, both disappearing, and revealing a character of earlier ancestral date.

It will be long before we can lay down precise rules which shall enable us to predict the effect upon the offspring of different parental unions. This could only be done by observing the actual results of different unions. We should probably, however, be for the most part correct in predicting pre-potency of a character in those cases where its ancestral age is much greater than that of the other blending element; and, on the other hand, a total disappearance of each character, with reversion, where both are of recent ancestral origin and divergent nature. Little more can be said in the shape of general statements.

1c. *The blending characters are normal, and belong to different tissues.* This, strictly speaking, falls under the last head, and therefore needs no further consideration.

In regard to the blending of unlike physiological characters, an interesting question arises—viz., Is it possible for two physiological blendings to lead to a pathological result? Suppose A. and B. to be healthy men, and C. a healthy woman. Is it possible that while the children of A. and C. are healthy, those born of C. by B. shall (*cæteribus paribus*) be unhealthy? This may seem an astounding question, but it is one deserving our serious thought. In a healthy organism there is, in the language of Spencer, equilibrium between the inner and outer relations. The living organism is what he would call a *moving equilibrium*—that is to say, it consists of an inconceivably complex array of forces, which

are able to keep in equilibrium with the forces of the outer world as represented by E. When such perfect equilibrium obtains, the organism is said to be perfectly adapted to its E. And if any marked alteration in the E occurs, this has to be met by a modification in the distribution of the bodily forces, by a process of adaptation, as it is called. Now, although each individual parent may be in perfect equilibrium with his or her respective E, it is quite possible that the mean structural product of the two shall be in no such perfect equilibrium with its E. Herbert Spencer, so far as I know, does not consider the possibility of disease thus resulting, being content to deal with generalities. Nevertheless, there is no doubt that some forms of disease may thus result. Let us see how.

It is a well-known fact that crossing is a cause of variability.* And, as might be expected, the variations thus resulting may be ill adapted to the E, and in this way predispose to disease; in some cases they may appear as actual disease, for, as we shall presently see, these new characters may be simple reversions, and such reversions, though normal in the remote ancestors from whom they are derived, may be entirely abnormal in their remote progeny. A branchial cleft, for example, though normal in a fish, would be totally abnormal during the post-partem life of a mammal. The crossing referred to is one between distinct varieties; but inasmuch as all human beings differ from one another, and some far more than others, it may occasionally happen that father and mother exhibit, in some particular, a great difference, so that their union may be, in respect to the particulars wherein they differ, more or less a cross, leading to a reversion, perhaps not to a very remote ancestral state, but to a condition of body entirely out of harmony with the existing civilized E.

But setting aside the question of reversion, it is quite possible that a considerable variation may arise from such a union, for it appears certain that "quite new characters" may result from crossing. "The common opinion of floriculturists proves that the crossing and recrossing of distinct but allied plants . . . . induces excessive variability, having the appearance of *quite new characters*" (that is, not mere reversions). Now, are we justified in

* *Vide* Darwin, "Variation under Domestication," pp. 252–255.

assuming that the variations resulting from such crossings shall be always physiological? It may be thought that it is incorrect to speak of "crossings" between the members of the human race, seeing that the term "crossing" refers to the union of separate varieties; but, be it noted, there is no strict difference between varieties of the same species and between individuals of the same variety, seeing that no two beings are exact alike, and that beings apparently very much alike may in some one particular be very much unlike, so that the union of two such individuals may be regarded as a cross in respect of that particular. In this sense, crosses are continually occurring among us. I do not assume that the hypothetical variations thus resulting will consist in such typical pathological states as gout or rheumatism, which have, for the most part, a known etiology, but I venture to suggest that certain anomalous states of the body may thus occasionally arise, and perhaps a condition of body rendering it especially prone to disease—rendering it, namely, very apt to respond pathologically to certain Environments.

2. *The blending of normal with abnormal.*—In this case the result is, as we should expect, a considerable diminution of the abnormality. If the normal parent be especially sound and strong in that point wherein the other fails, we might expect a good result, as when a man of strong and vigorous nervous system, digestion, or what not, marries a woman possessing the reverse. But the result may depend upon subtler conditions than we can always analyse. Sometimes the union of normal with abnormal may result in the complete annihilation of the abnormality, on the principle of reversion by crossing already alluded to.

We now have to consider the blending of abnormal with abnormal.

3*a*. *The abnormalities are of the same kind and affect the same tissue.*—Thus, the father and mother are, let us say, both neurotic, rheumatic, or phthisical. In such cases there will be a very strong tendency in the offspring to inherit the disorder. We have no right to assume that there will be an exaggeration of the pathological state, but we should scarcely expect a diminution of it. Nevertheless, if both parents

be strongly saturated with the same disease-tendency, it is rare to find all the children inheriting it. There seems, indeed, to be a great tendency in Nature to right herself in the offspring, if she be allowed a fair chance—if the offspring, namely, follow a hygienic mode of life. We shall presently see that this is due to the fact that diseases having for the most part a recent ancestral origin tend, like all recently acquired characters, to disappear in the offspring, not yet having attained a sufficiently strong hold upon the race to ensure their continued inheritance. But this tendency to revert to a pre-pathologic state will of course be far greater when only one parent is diseased (as in 2). Indeed, in such cases it will often be very strong; for, as already observed, if one parent be especially vigorous in that particular wherein the other fails, the two may be regarded as a cross in respect of that particular, and hence there may be a reversion to the pre-pathologic state—namely, health.

Some of the evil resulting from consanguineous marriages is due to the blendings now under consideration—namely, of like abnormalities of like tissues, for the same morbid tendencies are apt to exist in parents of near blood, as rheumatism, gout, phthisis. In regard to consanguineous marriages Darwin says:* "Whether consanguineous marriages, such as are permitted in civilized nations, and which would not be *considered as close inter-breeding* in the case of our domesticated animals, cause any injury, will never be known with certainty until a census be taken with this object in view. My son, George Darwin, has done what is possible at present by a statistical investigation, and he has come to the conclusion, from his own researches and those of Dr. Mitchell, that the evidence as to any evil thus caused is conflicting, but, on the whole, points to the evil being very small." But of course the result will differ vastly according to the health-value of the intermarrying family. If both parents, no matter how closely related, be perfectly healthy, so also will be their offspring. History tells us that consanguineous marriages were once the custom among certain peoples, and that such unions were attended with the happiest results as regards

* "Variation under Domestication," vol. ii. p. 104.

the offspring. We have distinct evidence that marriage of brother and sister, uncle and niece, nephew and aunt—nay, even of father and daughter, mother and son—has been countenanced by law.* Nevertheless, although no ill effect may be noticed during the first few generations, long-continued intermarriage has, there can be no doubt, an injurious effect upon a race, and it may be positively asserted that it is a "great law of Nature" that individuals of distant relationship should occasionally come into union.

3 *b* and *c*. *Abnormal blending of unlike kinds.*—The two abnormal characters may remain distinct, as when a man inherits gout from his father's side and phthisis from the maternal line; or possibly, in some rare cases, the two may blend into a hybrid, when we should have a true "*intermarriage of disease.*" Rheumatoid arthritis, or "rheumatic gout," has been thought to be a hybrid of gout and rheumatism, though, as Garrod has shown, these two diseases are perfectly distinct. I can think of no examples of such mongrel diseases worth mentioning, but it seems to me quite certain that many disorders must be of mongrel origin; for disease-tendencies are nothing else than peculiar structural states, and if normal structural states are capable of blending, the like must surely be true of abnormal ones. When we reflect upon the mongrelization of diseases which must be thus perpetually going on, we can understand how intricately compounded many diseases must be. This consideration alone should warn us against regarding all diseases as specific and unchangeable. We shall, however, in due course, meet with other evidence which will show the absurdity of such a supposition.

In treating of this subject of blendings, I have somewhat mechanically dissected the body into different elements or systems, and have considered the blendings of such individual systems as though they were so many independent units; but we know, as a matter of fact, that each part of the body works in harmony with all the others, and that the several parts are capable of influencing one another in many mentally disentangleable ways. Wherefore the blendings can only in rare instances be localized in their effects.

* *Vide* Huth on "Intermarriage of Near Kin."

CHAPTER XI.

Heredity (*continued*)—The Fixity of Structural Characters in Inverse Proportion to their Age, Ancestral or Individual—All Diseases of Recent Ancestral Date—The *Vis Medicatrix Naturæ*—The Tendency of Recently Acquired Characters to Disappear under Ancestral Forms of Environment.

The Fixity or Stability of Structural Peculiarities.—All living organisms tend to vary—that is to say, to take on new characters from generation to generation. In this way, structural peculiarities are continually being acquired and thrown off again. This is true whether we regard many generations of a successive species or a single individual. As regards the former, we find structural characters which have belonged to a species during thousands of generations gradually disappearing as the environment of the organism alters; and, as regards the individual, we shall find that structural peculiarities acquired by the individual himself may similarly be dropped,—such, for instance, as habits (which are nothing else than the functional manifestations of structural acquisitions) and pathological states of the tissues—namely, disease; and further, that under disease racial characters are apt to disappear.

Now, the fixity of such structural peculiarities, be they racial or individual, depends in large measure upon their age, ancestral and individual. Those structural peculiarities which are of greatest age are generally the most fixed and stable; on the other hand, those last acquired are usually the most unstable—most apt to disappear. Speaking of the race as a whole, the age of a structural peculiarity is measured by the number of successive generations in which it has occurred: the greater this number, the more tenacious is the structural character in question; while as regards characters acquired by the individual himself, those are the most fixed which he acquired earliest. Concerning

the fixity of what we may term racial, as distinguished from individual, peculiarities, this does not, perhaps, altogether result from the mere fact that a peculiarity has been repeated during many generations. This repetition may not be the cause, but the result, of a fixedness which is independent of repetition; for many species have, on domestication, more or less readily lost characters which they retained during countless ages in the wild state; and, in many cases, at all events, there "does not appear to be any relation between the force with which a character has been transmitted and the length of time during which it has been transmitted." * Nevertheless, although certain characters of great ancestral age readily disappear under an altered environment, we shall find the principle above enunciated to be on the whole a safe one. Darwin thus expresses his conclusion upon this head: "Notwithstanding these considerations, it would perhaps be rash to deny that characters become more strongly fixed the longer they are transmitted; but I believe that the proposition resolves itself into this,—that characters of all kinds, whether new or old, tend to be inherited, and that those which have already withstood all counteracting influences and been truly transmitted, will, as a general rule, continue to withstand them, and consequently be faithfully transmitted." †

A consideration of the embryonic changes would appear to afford a proof that repetition does actually *fix* a character. The early developmental changes of the embryo date back through millions of generations, and by incessant repetition have become rigidly fixed. In this way many remote ancestral characters, such as the branchial clefts, appear. It is true they soon vanish, but they are nevertheless fixed in the race, for they have in this way appeared during untold generations, and probably will continue to do so as long as man exists. But although many remote ancestral characters are thus retained, how great is the number that have been dropped! Characters which have been present during hundreds and thousands, nay, perhaps, even millions of generations, alike with such as have lasted for a few generations only, have thus been gradually lost, as the organism has become moulded to an ever-

* "Variation under Domestication," vol. ii. p. 38.

† *Ibid.*, vol. ii. p. 39.

changing environment, while other characters, which have remained structurally active during yet longer periods, have, by their tremendous repetition, become so fixedly organized in the great vital rhythm that they even now have a transient existence in the embryo. The accompanying diagram is intended to represent the mode in which characters are acquired and dropped again in the progress of organic evolution, also the ancestral age of different characters:—

FIG. 8.

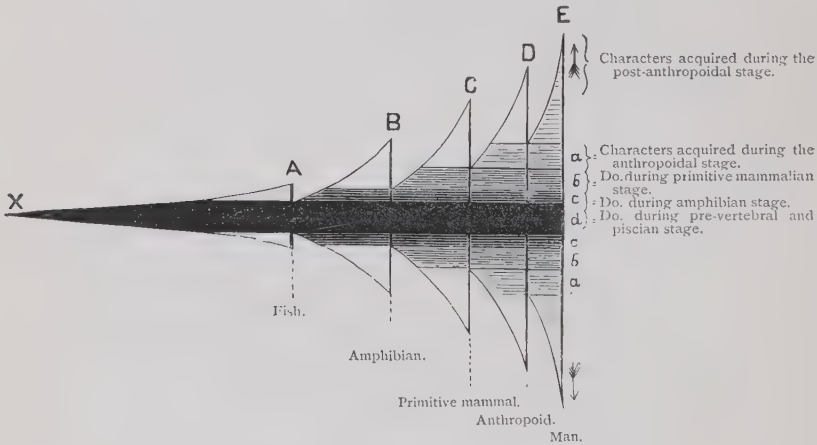


Diagram representing the Evolution of Man.

Evolution starts at X. The vertical lines, A, B, C, D, represent the developmental processes of man's ancestry at the following stages:—A, the primitive fish stage; B, the amphibian stage; C, the stage of the primitive mammal; D, the anthropoidal stage. The vertical line, E, represents the developmental processes of man himself. In all these cases the embryological processes are supposed to start from the centre of the vertical lines and to spread outwards. The horizontal shaded portions indicate the ancestral age of man's several structural characteristics. Thus, fixing the mind upon the vertical line, E, and remembering that development is supposed to start from the centre, we find the most early structural manifestations of the embryo to be of oldest date. These characters were acquired during the invertebrate and piscian stage of man's

ancestry.* They are represented by the central darkly shaded portion, *d*. The human embryo then takes on structural characters which were acquired during the amphibian stage. These are represented by the shaded portion, *c*. It then assumes characters acquired during the primitive mammalian stage, as represented by *b*, and so on. The unshaded parts of the diagram represent characters which belonged to the different ancestors of man, but which no longer appear in the human cycle. †

It will be convenient, while treating of this subject of structural stability or fixity, to consider, first, the tendency of structural characters, actually possessed by the individual, to *disappear* in the inverse order of their age—*a*, ancestral, or *b*, individual; and, secondly, the tendency of structural characters, of recent ancestral date, and possessed by either or both parents, *not to appear* in the offspring—this tendency being in proportion to the ancestral youth of the structural character.

We may accordingly frame the following propositions:—

I*a*. Characters which the individual possesses by virtue of heredity, tend, under disturbing influences, to *disappear* in the

* The line from X to A should be very much longer than here represented; for the distance in point of time between X and A is infinitely greater than that between A and E.

† It must be borne in mind that the various changes which take place in development (ontogeny), are not an exact epitome of the several ancestral forms of life, for not only have numberless ancestral characters been dropped as indicated in the above diagram, but there is an actual *vitiation* in the process of development, so that it no longer gives us a perfect ancestral history of the organism. So far as the process of embryological development is an exact reproduction of ancestral life, it is termed by Haeckel, *Palingenesis*, or inherited history (παλιν = reproduced). So far as it is not such an exact reproduction, he terms it Kenogenesis = vitiated history. (κενος = strange, meaningless). This aberration of development, as we may in a manner term it, has reference (*a*) to the period at which the different organs appear, some developing sooner, and others later, than in the ancestral forms of life; thus, in man there is an acceleration in the appearance of the gill openings, of the brain and eyes; and it has reference (*b*) to position—*i.e.*, an organ may develop from a different tissue from that in which it originally developed. Thus, the sexual organs—both male and female—in man originate from the mesoblast, while in the lower animals the male sexual organs originate from the epiblast; the female from the hypoblast. It would appear that in such cases certain embryo cells have migrated from one germ-layer to another. (See, on this subject, "The Evolution of Man," by Ernest Haeckel, vol. i. p. 10, London, 1879.)

inverse order of their ancestral age—that is to say, of their evolution.

This truth is particularly well shown under the disturbing influences of disease. It is further exemplified in the gradual dissolution of old age.

I*b*. Characters acquired by the individual himself tend, under disturbing influences, to *disappear* in the inverse order of their acquisition.

This truth also is well exemplified in disease and old age.

II. The tendency of parental characters *not to appear* in the offspring is in inverse proportion to their ancestral age.

Let us now consider each of these propositions separately.

I*a*. The instability of characters which are of recent ancestral date is well known to all biologists, and examples of it abound in the animal and vegetable kingdoms. The tendency of the moral nature to disappear before the other parts of the mind, under the disturbing influence of disease, or even of excitement, affords a familiar example of its truth. The advent of insanity, for instance, is generally heralded by an upset of the moral faculty; in other words, that mental ingredient which was last acquired is the first to go, the other parts of the mental organism being successively disorganized as the morbid process deepens. We have only to look around to have most painfully impressed upon us how slack is the hold of morality upon the multitude under certain disturbing influences. Let us take, for instance, the recent execution of the criminal, Pranzini, in Paris. The following I give from memory, but it fairly tallies with the description I read of it:—

"For several nights before the execution a huge multitude collected about the prison in the greedy expectation of seeing him guillotined. All classes of society were there, from the wealthy in their chariots to the most degraded portion of the populace. On these nights the crowd amused itself by singing filthy songs, having for their theme the poor wretch who was about to be hurried into eternity. At last the fatal night arrived, and in the first hours of the morning the victim was aroused from a deep sleep, and led pinioned through the gloating and screaming throng to his place of execution. When the knife had severed the head, the blood gushed out, staining the

ground about the place. The multitude then wildly pressed in upon the fatal spot, and the foremost among them dipped their hands or handkerchiefs in the blood. One of these rushed with bloody fingers after a group of gay women, striving to add to the rouge on their faces, and the women ran shrieking away."

Here we see the humanity of man for the time completely stifled, and the dormant instincts of his savage ancestors awakened. The history of the civilized world shows how ever ready these savage instincts are to crop up on the removal of the inhibitory influence of a loosely-attached humanity. The events of Pranzini's execution call to mind many very similar instances furnished by the history of the persecutions of the Christian Church.

Again, in the gradual dissolution of old age, how often do we observe the mental faculties falling away in the inverse order of their ancestral evolution; * and it not unfrequently happens that the moral faculty dwindles, while the intellectual powers remain in full vigour.

That structural characters of latest ancestral origin are most apt to disappear under disturbing influences is nowhere better shown than in the processes of disease. This conclusion might, I think, be arrived at *à priori*.

Whether or not all diseases are accompanied by structural alteration is a question that will be discussed in another part; but this much is at once certain, that where distinct structural change does occur, the process is one of dissolution. In a few instances, such as the more highly organized tumours, this may not *seem* to be the case; but it is at once evident that, in the vast majority of diseases accompanied by structural change, there is distinct tissue dissolution. There is no advance, no improvement, in the affected tissue; on the contrary, there is retrogression, deterioration—and this is dissolution.

Evolution and dissolution are opposite processes: the one may be roughly defined as a building-up, the other as a pulling-to-pieces. Now, the fact that disease is a vital process suggests

* I use the term "ancestral evolution" in contradistinction to those evolutionary processes which take place in the individual, not as the direct result of heredity, but of personal acquisition.

at once that this pulling-to-pieces will take place in the inverse order of the putting-together—that the dissolution will be a more or less exactly inverted evolution. Often enough dissolution is by no means an exact inversion of evolution. At death, for instance, rapid dissolution occurs; but when, let us say, a full-grown man dies, we do not find him passing through the several phases of youth, childhood, and fœtal life, finally becoming an ovum again. There is, however, a great difference between the dissolution which occurs after death and that which attends disease: while in the one case evolution is completely undone, in the other it is only partially undone, for disease being, as just now observed, a vital process—*i.e.*, the tissue undergoing dissolution being still alive—it must have, if we may so put it, a certain amount of evolution still left in it—the structure has not been pulled to pieces to its very foundations. Now, as dissolution proceeds from stage to stage, one would naturally expect the tissues to be unbuilt in an inverse order to that in which they were put together—from roof to foundation, so to say; for if the process commenced at the foundation, all analogy leads us to assume that complete dissolution would at once occur. These are the grounds on which I have concluded that the principle for which we are now contending follows from *à priori* reasoning.

I am not for one moment contending that the dissolution in disease is always an exact inversion of evolution, but merely that there is a tendency to such inversion. No one, for instance, would assert that in pneumonia or nephritis the lungs and kidney pass inversely through the various phases of embryonic development. Although the principle applies more or less to the organ as a whole, it is in the study of the individual elements of the tissues that we have the best proof of its truth. When the morbid process leads to rapid dissolution, it is impossible to trace carefully the various phases of the backward process, but when it takes place by slow and steady steps this may be sometimes done.

No disorder presents a more favourable opportunity for this study than progressive muscular atrophy. In the first place, the disease is a slow and, for the most part, steady one; then, again, the process limits itself to a specialized tract of cells;

and, finally, these cells possess a well-marked structure, by which I mean one that we can detect by examination, for we have seen all cells possess a highly complex structure.

The degeneration of the anterior ganglionic cells in progressive muscular atrophy is undoubtedly, to a large extent, an inverted evolution. In order to be sure of this, it is necessary to study the evolution of these cells. This has been done by observing their appearance at different stages of development. If we examine the cervical region of the cord during early infancy, the anterior ganglionic cells will be found to be not only simple in structure, but also comparatively few in number, this immaturity corresponding with the volitional incapacity of the young infant, who is, as yet, utterly helpless. Gradually, however, they increase in number and complexity: at first round and small, they enlarge, and, at the same time, push out a number of branching processes. Thus are formed complex motor centres, and it is upon the grouping of these cells into centres that the proper grouping of muscles in ordinary voluntary acts, in very large measure, depends; for, be it remembered, what is apparently a very simple muscular act, is found, when dissected into its component parts, to be a very complex process. It may be remarked, by the way, that the growth of voluntary power is not a mere matter of education, as taught by Bain, for, as just observed, the structural basis whereby voluntary action becomes possible, is, at birth, not yet developed in the nerve ganglia. Moreover, the voluntary cortical centres are at this time equally backward in development; so that, even if the new-born infant possessed fully developed mental powers, voluntary action would be quite impossible.*

In considering the structure of the anterior ganglionic cell, we have to remember that one of its processes is prolonged into the axis cylinder process of a motor nerve fibre, this axis cylinder process, as it has been termed, becoming, in due course, coated with medullary sheath and neurilemma; and the entire nerve fibre thus constituted terminates in the

* Bastian. I do not intend to imply by the above that voluntary power is not gained by education, but rather that the immaturity of the motor mechanism at birth must be taken into account when studying the growth of the will.

motor-end-plate of the striped muscle fibre, so that the motor-nerve-ganglion-cell,* the nerve fibre, and motor-end-plate form one continuous strand of protoplasm—a more or less independent tissue unit—whereof the ganglion-cell forms the head and governing portion; for anything which cuts off its influence, whether it be destruction of the cell itself or a severance of the nerve fibre, causes degeneration of the fibre thus detached from the governing influence of the cell.

If we study the development of the nerve fibre, we shall find the axis cylinder first appearing; next, the medullary sheath; and, finally, the neurilemma.

Now, in progressive muscular atrophy, it is found that, so far as we are able to observe, the process of dissolution of motor-nerve-ganglion-cell and nerve fibre is an inversion of the evolutionary process as above sketched. First, as regards the cell: degeneration affects first the finer ramifications of the branching processes; these become less complex, and gradually disappear; soon the main stalks begin to fade away, leaving the cell a mere round mass, which in course of time becomes angular, and finally, it may be, disappears. As regards the nerve fibre: the neurilemma is the first to disintegrate; next the medullary sheath breaks up; and, finally, the primitive axis cylinder degenerates.

The above remarks upon the evolution and pathological dissolution of the motor-nerve-ganglion-cell and fibre apply with equal force to the striped muscular fibre, which receives its nerve supply therefrom; but there is no need to give a detailed account of the evolution and pathological dissolution of the muscle-cell. It is sufficient to state that the one is, in large measure, an exact inversion of the other.

With the exception of these two examples of complex ganglion-cell and complex muscle-cell, we are unable to trace with any accuracy the evolution and pathological dissolution of individual cells, and this for manifest reasons. Few, if any,

* This term is, I think, preferable to "anterior ganglion cell," because it can be applied to the similar ganglion cells (forming the so-called "nerve nuclei' of the brain) whence the motor cranial nerves take their origin. By using the same term to denote all these fundamentally similar structures, we at once mentally group them under the same head, and it is right that they should be so grouped both for physiological and pathological purposes.

other cells possess an *obvious*, discoverable structure, and such being the case, it is impossible to trace the steps of their evolution in any detail, and equally impossible to study the reverse process with any minuteness. But what little we know of the evolution and dissolution of such cells fully accords with the conclusion we have reached; and could we trace accurately the several phases in the evolution of, say, a liver-cell—(and the process is infinitely more complex than at first sight appears, for, as I have already insisted, every active cell in the body has a highly complex structure, and therefore a highly complex evolution)—all analogy leads us to conclude that we should find the pathological dissolution in very large measure an inverted evolution.

Hitherto I have spoken only of structural dissolution; functional dissolution has not been mentioned. It should, however, be remembered that function is dependent upon structure: the two, therefore, must stand or fall together. A careful study of the perverted functions of disease and the order of their appearance fully bears out the conclusion we have already reached. Indeed, we have in such a study a far more accurate test of its truth, for not only are we able to study the functional changes from day to day, and even from moment to moment—a thing manifestly impossible in the case of internal structural changes—but we have in functional change a far more delicate test of dissolution, seeing that a structural change which is quite outside the reach of microscopic observation is capable of producing very obvious functional alteration. A large chapter might be written on Dissolution in Disease as manifested by altered function, but there is no need to pursue this subject further.

I*b*. We have now to consider the influence of age upon characters acquired by the individual himself. The second of the above propositions affirms that "characters acquired by the individual himself tend to disappear in the inverse order of their acquisition." The truth of this proposition is forcibly shown by a study of human nature; the longer a habit is indulged in, the more difficult it is to shake it off. The latest acquisitions are certainly the most fleeting, and this fleeting tendency of recent acquisitions becomes more and more pronounced as life advances,

when the habits and thoughts of early years are apt to re-assert themselves in full sway. Since all habits are acquired structural peculiarities, it follows that the shaking off of a habit is the disappearance of such a structural peculiarity.

Now these considerations have practical application for the physician, because many habits are capable of affecting the health for good or evil. It is needless to speak of the countless healthy and unhealthy ones, such as the habit of regularly going to stool, or the baneful habit of "drinking."

Our proposition again holds true in respect of actual disease. The longer a disease lasts, the less is the chance of recovery. Hence the necessity, where possible, of nipping it in the bud. For instance, an acute disease like pneumonia or acute nephritis has a much better prognosis than one that is chronic—to wit, granular kidney—from the very fact that the one is of recent origin while the other has lasted some time. It might be argued, "Of course, because the very fact of its chronicity suggests that it was from the beginning destined to become chronic." This is quite true, but, altogether apart from such a consideration, a chronic disorder is less likely to get cured, for the longer it lasts the *faster* does it cling, by making a deep impress upon the body fabric; and even if we were able to check the progress of a chronic disease—that is to say, remove those causes which may have destined it to be chronic from the beginning—this deep impress would still remain. Take as an example granular kidney. The precious protoplasm, so cunningly adapted to the removal of the nitrogenous sewage, is crushed and destroyed by the growth of a dense fibrous tissue, which it were folly for us to attempt to remove; moreover, the heart, arteries, and many other tissues are markedly affected, so that the disease can no longer be flung off, leaving the body as it was before. But this may happen in acute pneumonia or nephritis, because the structural changes of a few weeks' duration are, so to speak, of a more superficial nature.

II. What is true of the individual is true of the race. "Those characters which are of most recent ancestral date show the greatest tendency to disappear, or, more accurately, *not to appear*, in the offspring." Natural variations of great ancestral age—characters, that is to say, which have passed down many

generations, become so structurally welded with other parts that they are with as great difficulty dropped from the race as is "granular kidney" from the individual; for, all parts of the body being more or less interdependent, a variation in one part necessarily leads to alterations in other parts, these again to others, and so on; and thus, in the course of ages, the initial variations may become so ingrained as to be incapable of suddenly vanishing; and this seems to afford a strong argument in favour of the proposition that mere repetition must render a character more permanent. I suspect that whenever traits of great ancestral age are rapidly dropped under changed conditions of life, they are of a so-to-speak superficial character, not largely influencing or being influenced by other tissues; and thus, not being intricately interwoven with the rest of the body-fabric, they are detached with comparative ease.

It is very important to note that the ancestral age of any particular pathological variation—that is to say, the number of afflicted generations—is usually not great. In thus speaking of the ancestral age of any particular disease, it will be observed that I refer, not to the date of its first appearance in the human race, but, as I say, to the number of successive generations of the same family labouring, actually or potentially, under that disease.

What are the grounds for thus asserting that the ancestral age of disease is short? This conclusion follows from the doctrine of natural selection. Through untold ages there has been a survival of the fittest, such survival leading to the evolution of organisms structurally adapted to their respective environments. Now, an individual afflicted with disease—that is, a pathological variation—is not thus adapted, and tends, in consequence, to be weeded out. Thus it happens that a serious disease would have little chance of being handed down through many successive generations of one family, for ultimately extinction must ensue. These remarks do not so forcibly apply to the lesser ailments which seem to be a necessary accompaniment of animal life, nor do they apply in any way to diseases which only appear after the procreative period of life, since these can in no way affect the offspring: but such diseases are very rare.

Wherefore we may say that, in proportion as any particular disease is dangerous to life, and in proportion as it occurs early in life, its chance of passing along several generations becomes less.

As regards those lesser ills to which flesh is heir, natural selection will play some part. Such of them as depend upon a general weakness of body will tend to be weeded out, through the weeding out due to such general weakness. But there are many local morbid actions quite consistent with thorough vigour of health, and having no power to shorten life. Thus, a family of remarkable bodily vigour is very liable to nasal catarrh. The father and several of the children suffer therefrom, and the tendency can be traced back through several generations. Let me instance more particularly one member of the family—a son, approaching the prime of life. In mind and body he far surpasses the average man, his sole apparent weakness, excepting perhaps a slight dash of the nervous temperament, being this tendency to nasal catarrh. Let him expose himself as he will, there is not the slightest inflammation of the throat, bronchi, or lungs, not the faintest rheumatic twinge; but he is rarely free from some degree of nasal catarrh, and this under exposure becomes acute. The tendency runs back, along the father's side, so long as there is any family record; but, inasmuch as the ailment is no part of a constitutional state tending to premature death, and is, moreover, strictly local and devoid of danger, it might as such be transmitted *ad infinitum*, were it not that the proclivity tends to be diluted at each successive marriage. Let us, however, suppose the catarrh in question to be part of a strumous diathesis, it would then have less chance of transmission, seeing that this diathesis tends to family extinction; or, let a similar catarrhal tendency affect the larynx in place of the nose, there would, under such circumstances, be no possibility of a long-continued transmission, for it would inevitably kill by occluding the larynx. Thus, natural selection explains the interesting fact that hosts of persons now living have suffered from absolute occlusion of both nares, while there are none, excepting such as have been saved by tracheotomy—and their number is very few—who have suffered from a similar complete occlu-

sion of the larynx. Natural selection, alike merciful and merciless, prevents the inheritance of such a fatal tendency, by yearly sacrificing thousands. From these examples we see how fatal disorders, occurring before the period of procreative life, cannot well pass through many generations, while such as are not fatal may attain considerable ancestral age.

We, may, therefore, conclude that any given instance of serious pathological variation is of comparatively recent ancestral date: whence it follows, from the principle just now enunciated (namely, that the fixity of a variation depends in large measure upon its age), that pathological variations are for the most part unstable. In other words, a diseased state shows a great tendency to revert to the *status quo ante*—viz., health. This tendency shows itself in a twofold way: first, in the tendency of a permanently diseased state in the parent not to appear in the offspring; for, although disease is undoubtedly hereditary, yet we see " Nature " ever making a strong effort to throw it off. (This is best shown where man and wife have very many children: speaking generally, we shall find that only a small minority will inherit the disease. It is in such large families, indeed, that heredity in disease can best be studied.) Secondly, the tendency to fling off a disease is shown in an individual who has himself acquired it. Instance the several acute disorders, such as pneumonia and nephritis. It is, of course, not to be supposed that the pathological acquisition can be thrown of—that there can be reversion to the *status quo ante*—where there is a gross organic lesion, such as a mutilated heart valve or a fibrotic kidney; but the truth of the principle is shown in the tendency of these parts to be healthy in the offspring.

Disease must, then, be regarded as a more or less temporary acquisition, tending under a proper E to disappear. This tendency shown by diseased tissues to revert to their antemorbid state is learnedly called the *vis medicatrix naturæ*.* I find that Paget, if I understand him rightly, explained this *vis medicatrix* in a somewhat similar way.†

* H. Spencer brings the *vis medicatrix naturæ* under his principle of equilibration. See his "First Principles," chapter xxii.

† "It seems probable that in embryo life there is, generally, a tendency to

It is impossible for the physician to exaggerate the importance of the *vis medicatrix naturæ.* It shows him how much he has to hope from a careful regulation of the E, not only in acquired disease, but in inherited tendencies; it makes him feel, under a crushing sense of the terrible power of heredity, that he has yet within his hands the means by which he can do successful battle with it. His problem, in any case of hereditary tendency, becomes how to produce a reversion by placing the individual, as far as possible, in an E as like that of his primitive ancestors as the altered conditions of life will allow, and to supplement or correct this E by carefully applying the medical knowledge he has so laboriously acquired.

We may here fittingly turn aside for a moment to inquire into the nature of such an E. From the habits of the primitive savage we learn that man was *intended* to live in the open; —or, to speak more scientifically, he has evolved from a lowly being under an exposed E; to go no further back than his simian ancestors, we find them living in the open, under no other shelter than that afforded by the branches of trees. Man having then evolved under exposure—beneath the free canopy of heaven, it follows that he must be, in the main, adapted to a life of exposure,—not, like the mole, to a subterranean existence, nor, like the whale, to an aquatic life. Now, both of these last-named animals have evolved from ancestors living upon the dry land, by gradual adaptation to a changing E. In like manner and through unnumbered generations the human body has been changing in response to a changing E; and it might be argued that, just as the mole has become modified for a life underground, and the whale for an aquatic life, so has primitive man become structurally adapted to a life spent under a roof. But he has not. As we shall see later on,

recovery from the morbid conditions transmitted from parents: a tendency to revert to the true healthy type of structure and composition. Such a tendency would be in accordance with the general rule of tendency to reversion from all variations of specific characters, and would be a part of that tendency to recovery of health which suggested a *vis medicatrix naturæ*, and which we may observe through life, diminishing as age increases, but never quite lost."—*Clinical Lectures*, by Sir J. Paget, p. 408.

such a sheltered E is necessarily fatal to man: one or two generations may linger on under it, but soon extinction occurs. It is, I say, "a necessarily fatal E," an E to which the human organism cannot adapt itself. Other organisms can—beetles, rats, mice; but the monarch of the earth sickens and dies under it. Wherefore, casting our eyes back through the long past, we learn a lesson from our far-off ancestors. We find that man was "intended" to live in the open.

The same conclusion is forced upon us if we seek information in another direction. Let us watch a healthy child; study his *instincts*. They are worthy of study, for, as we shall see in another part,* instinct is, in the strictest sense, the voice of "Nature." The child is living, let us suppose, in the country. So soon as he can toddle, what does he do? Stay in doors? No. He is soon roving about the country, for no healthy child will keep in doors unless compelled. Wind and storm have little fear for him—off he will go. What country-bred child does not remember the agony of being kept in during a rainy morning! Soon, as he grows older, he begins to climb the trees, like his simian ancestors. What healthy boy—nay, may I not even say, girl?—living in the country, has not climbed every available tree in the neighbourhood? Dickens somewhere speaks of the little sparrows in some old London "inn," flying about from tree to tree, and "playing at being in the country." How many of the London children make a more ghastly imitation of Nature!

In the suburbs, however, the attempt may be more successful. For example, a gentleman, living in the suburbs of London, has a few well-grown trees at the end of his tiny garden. When his eldest girl was five or six, she took to climbing these trees. No one had shown her how, for, being the eldest of the family, her brothers were too young. A short time ago I visited this gentleman on a summer's afternoon, and, looking out of the window, beheld the same maiden (now fourteen) sporting among the branches of the trees. This habit of the girl has given great trouble to a kindly old lady next door. She has

* *Vide* Part II.

been living in fear that the child would kill herself (how many children, I would like to know, have thus killed themselves?), and now, perhaps, she thinks it very "improper." Happily, the parents of this young lady have brains, and so they leave her alone. Unfettered by the conventionalities of Society, they have allowed her to follow the ways of Nature, and her limbs have grown in Nature's own way.

Wherefore let all children be brought up in the country, let them be out of doors while it is light, and let them climb trees, and indulge in all such pranks (except the mere savage ones) as Nature dictates. Those instinctive habits of which they will require to be cured are not the hygienically, but the morally bad, for the morality of the young child is very largely that of his savage ancestors, and ill-adapted to the requirements of a civilized community, which demands a morality of great complexity and refinement. Thus, the innate tendency to cruelty should be stamped out, the habit of throwing stones, of making grimaces, and so forth. Some of these habits are most interesting. To wit, the tendency of boys (not girls!) to go about in tribes armed with sticks and stones—Nature's own weapons—and to engage similar tribes of other boys in battle. I quite recently saw this in a London suburb. A tribe of small boys thus armed was at one end of a short street, engaged in animated talk about the enemy. Presently, at the other end of the street, the latter appeared. Then, with a *distinct war whoop*, the battle commenced by a throwing of stones. The enemy proved to be the weaker, for, upon their antagonists attempting to engage them at close quarters, they rapidly fled! I say, I do not counsel the education and development of the savage qualities here exemplified. We must civilize the young, and bring them up in a beautiful morality, but let us beware lest at the same time we annihilate all those instincts which show so distinctly what are the proper ways of youth.

So much for fresh air and exercise. What about food? Nature has provided a food for the first year: therefore, let the child have it, and *nothing else*. But when Nature's fount begins to run dry, what then? Again watch the ways of

children. All children in the country help themselves largely to the vegetable diet provided by Nature. They eat herbs and berries, roots and nuts, like their savage and simian ancestors. Sometimes they even rob orchards! I think it may safely be said that children, as a body, prefer a vegetable to a meat diet. Almost every child prefers fruit to meat. No doubt allowance must be made for vitiation of instinct, and some children may manifest a great liking for meat; they may be taught to like it, just as pigeons and other vegetable feeders may, or as they might be taught to like many other things—gin, for instance. Here, again, we are aided by the study of man's remote ancestors. His simian progenitors were entirely vegetable feeders, and, although cannibalism is indulged in by certain savage tribes, yet their staple diet is undoubtedly a vegetable one. Apart, however, from these considerations, we have the evidence of experience, which shows that an excess of meat diet is injurious. (Butchers are short-lived.) Therefore, man's diet should be mainly vegetable; that of children almost entirely so. Our medical experience teaches us, moreover, that the supply should be abundant. All doctors now agree that, till the period of development has ceased, the individual should have as much food as he can eat—provided, of course, that it be suitable.

Nor should the mind of youth be unduly stimulated, Here, again the natural instincts of the child help us. Every healthy child revolts against the enforced incarceration of school hours, and against the effort of fixing the mind long on the same subject. Indeed, the early education of the young, more especially of such as come of a nervous stock, requires the greatest skill.

I say it is well to study the E of our remote ancestors, and, making due allowance for subsequent evolution, to erect a system of bringing-up for our children. And let us be careful that all children coming of an unhealthy stock be placed, as far as possible, under this E, for we have seen that the age of any particular disease is not great, and that its tendency to disappear increases in proportion as the E approaches that of our remote ancestors. One is, I think, justified in assuming that a reversion to an ancestral state would be more likely to occur

under the E which obtained during the exhibition of that particular state than under any other. It does not, of course, necessarily follow that reversion to an ancestral state will in all cases follow on a return to such E—that all domesticated plants and animals, for instance, will necessarily revert to their wild state if exposed to their original E. All I maintain is, that such reversion is far more apt to occur under that form of E than under any other. Darwin was careful to point out that the evidence in favour of the common statement, that reversion to the wild state always takes place under the pre-domestic E, is difficult to obtain. He, nevertheless, writes as follows: "As our varieties certainly do occasionally revert, in some of their characters, to ancestral forms, it seems to me not improbable that, if we could succeed in naturalizing, or were to cultivate, during many generations, the several races, for instance, of the cabbage, in very poor soil (exposing them, that is to say, to an E very like the original ancestral one), they would, to a very large extent, or even wholly, revert to the wild aboriginal stock."*

I make no doubt that, under the kind of E I have denoted, many hereditary weaknesses might be obliterated—nay, even more than this, that a most deteriorated race could again recover its original perfection. Let us take a typical cockney, stunted in body and mind—5ft. 2in. in height, with his other measurements proportionally dwindled—I make no doubt that if this man, with his cockney wife, were placed under such an E as I have sketched, and their children and grandchildren after them, the physique would rapidly assume its pristine mould. Such thoughts should give us hope. Are there not many particulars wherein we are inferior to our ancestors? Take the single instance of the teeth. It is known that the teeth of civilized peoples are getting worse and worse. What others think of this I know not, but to my mind it is a very serious matter. I suppose primitive man practically never suffered from toothache. How different with us! If we could reckon up the agony suffered by those now living from toothache, what a terrible total we

* "Origin of Species," sixth edition, p. 11.

should get, leaving out of account the secondary but even greater evils of digestive and reflex troubles, to say nothing of the unsightliness. Now, may we not believe that, under a proper E, a race most degenerate as to its teeth might in course of time become completely regenerated in this respect, recovering to the full the strong and beautiful teeth of their ancestors?

CHAPTER XII.

Heredity (*continued*)—Reversion—Its Two Chief Causes—Peculiarity in the Evolutionary Process and Partial Dissolution of a Mature Tissue.

Reversion.—In the disappearance of a recently acquired character, whether physiological or pathological, we have an example of what is technically termed reversion. This principle must now be considered somewhat in detail.

The following I hold to be the three great causes of reversions:—

1. Peculiarities of *ante-partem* E, causing arrest or perversion of development.

2. The union of parents having uncombinable tendencies—such uncombinable tendencies being for the most part of recent origin, and of divergent character.

3. Peculiarities of E, *ante* or *post partem*, whereby a *mature* tissue is compelled to revert to one of inferior order.

In the first two varieties the reversion is due to a peculiarity in the process of development—to a peculiarity, namely, in the grand evolutionary process; in the last, it is due to an undoing of evolution, or, to speak more accurately, to the partial undoing of a more or less completely evolved tissue.

Peculiarities of *ante-partem* E may lead to reversion in a twofold way—(*a*) by interference with the due sequence of embryonic events: in this way the development of certain organs and tissues may be *arrested*, the individual being born with characters belonging to remote ancestors; (*b*) the peculiar E may lead to such perversion of embryonic processes that *development proceeds more or less on remotely ancestral lines.*

As an example of arrest, we may instance the occasional persistence of a branchial cleft, and many forms of idiocy in which far-off ancestral mental traits may appear. Thus Maudesley has recorded several cases of idiocy where the indi-

vidual has shown marked likeness in his ways and instincts to certain of the lower animals. There can be little doubt, I imagine, that the arrest in such cases is due to peculiarity of *ante-partem* E. As an example of reversion, due to peculiar *ante-partem* E, causing not a simple arrest merely, but such a perversion of embryonic processes, that development proceeds on old lines, we may instance the stripes which sometimes occur on the young foal. These are evidently derived from the zebra—a far-off progenitor of the horse. The fact that they are observed every now and again in the foal shows that they must always potentially exist in the embryo. What is it that causes this potentiality every now and again to become an actuality? The union of parents having uncombinable tendencies may afford the true explanation of the reversion —of which more presently. Another possible cause of the reversion in question is the one under consideration, namely, a peculiarity in *ante-partem* E, which prevents the development of the skin from proceeding on the lines peculiar to the horse, causing it, on the other hand, to progress on more ancient lines. Thus, at the time of fœtal life, when the embryo is most like the zebra as to its integuments and such tissues as influence their development, one may suppose some such accidental dislocation of the molecular processes of the one or the other to take place, that the further development of the integuments proceeds on the old lines peculiar to the zebra.

This mode of viewing the matter may be rendered clearer by a diagram. In Fig. 9, AB represents the fully developed zebra skin; CD, the fully developed horse skin; O being the starting point of development. Up to the point X we may suppose the development the same for each. But henceforward there is a divergence,—in the case of the zebra development proceeding in the direction of A and B; in the case of the horse, of C and D. So far as the latter is concerned, the unshaded part represents a dropped character (this being diagrammatically indicated as in Fig. 8).

Now, if we suppose that the integuments of the foal have arrived in their development at the point X, we can imagine that a peculiarity of E might lead to such molecular dislocation

of the developmental processes that further development shall proceed on the old lines XA, XB.

It may be that stripes like those met with in the zebra are

FIG. 9.

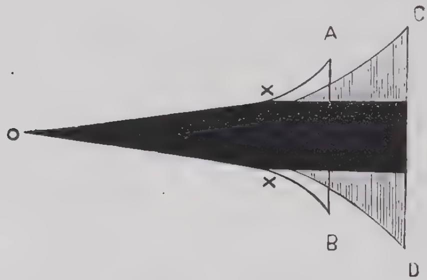


Diagram showing how a character existing potentially in the embryo may be converted into an actuality.

always normally present in the embryo foal at some period of its development, and, if such is the case, one may account for their presence in the young foal by supposing a simple arrest in development, be the cause what it may, peculiar E or not. But let it be well noted that many reverted characters are never actually present in the embryo—only *latently present;* and whether the zebra stripes are always present in the embryo foal, or whether their occurrence in the young foal is merely the conversion into an actuality of a power latent in the embryo, matters not much. The diagram assumes the undoubted fact that the embryo has latent powers which may or may not develop into actualities, and we shall not err greatly if we assume the pronounced stripes of the zebra to be only latently present in the embryo foal.

Whether this method of viewing the conversion of a *latency* into an *actuality* be correct, I know not. It will be observed that in this attempted explanation I am regarding the life of an organism as a cycle—a complex rhythm, and the development of a latency as the substitution of a previous rhythm for a present one, owing to peculiarity of E. But, be the explanation what it may, let us ever bear in mind that an organism is the seat of many thousand such latencies.

2. We now come to the second cause of reversion, namely,

the union of parents showing structural characters of divergent character; in consequence of this divergence they refuse to blend, and thus display a *status quo ante*. Such characters are of more or less recent acquisition.

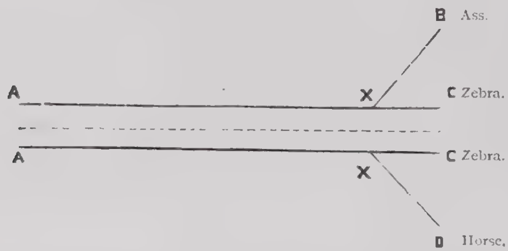
It is a well-established biological fact that reversions most frequently occur when distinct species, or pronounced varieties of the same species, are crossed. Whatever the explanation, the fact remains, and, as we shall see, it has a most important application in medicine. In the fifth chapter of his "Origin of Species," Darwin illustrates this result of crossing. He tells us that zebra-like stripes frequently result from the crossing of the several species of the horse genus: the ass, horse, quagga, hemionus—all of which are descended from the zebra. Another striking illustration of the same principle is afforded by the pigeon. There are over three hundred varieties of this bird, all of which are undoubtedly descended from the *Blue* Rock pigeon, a bird very like our Wood-pigeon. Now, when distinct breeds of various colour are crossed, there is "a strong tendency for the blue tail and bars and marks to reappear in the mongrels." The author goes on to say that there is evidently "a tendency in the young of each successive generation to produce the long-lost characters" (note this in reference to my remarks on potentiality), "and this tendency from unknown causes prevails" in such crosses. The above hypothesis affords, I imagine, some explanation. We may suppose, namely, that the recently acquired characters refuse to blend; that the parents are, in fact, barren in respect of them, so that there is a reversion to a *status quo ante*—to the condition of things which obtained before the acquisition of the non-blending characters.

Up to the point of ancestral divergence, any two different species of the same genus may, in fact, be regarded as of the same species, and therefore, as we should expect, the development of the mongrel offspring thus far proceeds harmoniously; for are not these the lines on which it has proceeded for many generations—thousands, it may even be tens of thousands? The germ and sperm, thus far, are, so to speak, perfectly adapted to each other; but beyond this point each element has different tendencies: from the one parent comes a tendency to reproduce one set of peculiarities, and from the other

a tendency to produce another set—perhaps of a totally opposite order. Therefore, henceforward the process of development tends to be somewhat chaotic. The two tendencies, coming into union for the first time, show a disinclination to blend, and in this chaotic state, pre-potency no doubt plays an important part, certain recently acquired characters occasionally showing great proneness to appear in the offspring; but the general rule is that such recently acquired characters tend to be dropped, the offspring revealing characters peculiar to a remote ancestor—that is to say, the *status quo ante* the divergence. Or, putting the matter in another way, we may say that the two sets of characters acquired after the point of divergence are barren, one with another. Viewed from the embryological standpoint, each organism is, as far as this point, practically of the same species, and therefore capable of perfect sexual reproduction one with the other, but after it the two are of different species, and more or less barren.

The above explanation may be rendered clearer by the accompanying diagram. The line AXB represents the develop-

FIG. 10.



ment of the integuments of the ass, AXD that of the horse, AC, AC=development of zebra. X in each line marks the point of divergence. From A to X the lines are parallel. This signifies that the developmental processes are thus far parallel and in harmony. But beyond this point the diverging lines, XB, XD, signify diverging tendencies. So that if AXB represents the germinal tendencies of the ass, and AXD those of the horse, there will be perfect union up to X; beyond this XB, XC will more or less refuse to blend, and development will tend to proceed on the old lines to C.

3. In the different kinds of reversion hitherto considered, the cause is an error or peculiarity in the process of development; but there is another kind of reversion, which is apt to be left out of account—namely, the reversion of a mature and properly developed tissue to a remotely ancestral state. I have already instanced the loss of the moral nature in the commencement of an attack of insanity. In such a case, the cortical tissue reverts to a state belonging to pre-moral times. Now, all the tissues of the body exhibit a like tendency to reversion. If the cell-E necessary to the maintenance of a high state of evolution, be vitiated, we find the tissue reverting to a more elementary form—to one belonging to a remote ancestor. What, for instance, is the effect of an irritant when applied to living tissues? That curious process which still continues to bother the pathologist occurs—inflammation. Now, if an inflammation is not so slight as to end in resolution, nor sufficiently violent to destroy the tissue, the mature tissue is replaced—as Cornil and Ranvier put it—by an embryonic tissue; in other words, there is reversion of the part to a remotely ancestral state. Take, for instance, inflammation of muscle-tissue: the mature muscle fibres disappear, and their place is occupied by small round cells, amongst which small capillaries presently develop, forming the so-called granulation-tissue. If the irritant be removed, this tissue will attain higher development: there will be an abortive attempt at the production of muscle-tissue, although little more than fibrous tissue will be formed. In round-cell sarcoma, the process is similar. Sarcomatous and granulation-tissue are, I suppose, fundamentally the same. In sarcoma, as I shall argue in another part, the irritant, or as I should prefer to put it, the mal-cell-E, consists of a specific bacillus. This constitutes an abiding mal-E. Hence the morbid process is continuous, and the cells, being continually irritated, are prevented from developing into a mature tissue. In the round-celled sarcomata no higher development whatever is permitted, but in the other varieties a faint effort is made in that direction. In the *epitheliomata*, we probably have a similar reversion to an elementary form of gland-tissue, and it may be that the same is true of the acinous carcinomata. In the myxomata,

again, under a cell-E concerning the nature of which I do not profess to know anything, a mature tissue takes on a remotely ancestral form—a form, namely, that is met with in the most lowly organisms, as, for example, the jelly-fish; and in this connection it is interesting to note the tendency which the sarcomata show to undergo mucous degeneration. In old age, again, the higher epithelial tissues perish at the expense of those which are merely connecting: under the failing supply of healthy blood, there is a reversion to a simpler tissue. Let it ever be remembered that the human organism contains the potentialities of countless ancestors, and that these potentialities may, under fitting conditions of E, be converted into actualities.

In the *Lancet*, No. XXII. vol. i. 1887, will be found an interesting communication by Dr. Gresswell, on the "Origin of Tumours by Reversion." This communication suggested the following remarks from me, which I venture to quote here, since they bear upon the present subject:—

"I have been inclined, for some little time past, to regard certain new formations as reversions, of limited patches of tissue, to an ancestral type—notably, the enchondromata, myxomata, sarcomata, and the new formation occurring in consequence of inflammation—namely, granulation-tissue, including, of course, the granulomata. It must not be forgotten that the reversion of which Dr. Gresswell speaks is not the ordinary reversion which occurs during the embryological development of an organism, but the reversion of a fully evolved and specialized tissue to one of remotely ancestral type. That such a fully developed tissue may thus revert is a well-recognized fact. Dr. Maudesley points out that during the cerebral disturbance which heralds an attack of insanity, the moral faculty—viz., that mental element which has been last acquired—is generally the first to go. This shows a reversion of cerebral tissue to an ancestral type. It is well to bear in mind that the tissues of a fully developed organism have many potentialities which only need fitting opportunities to display themselves. These consist in modifications of cell environment. A good example of such latent capacities is afforded by disease, atrophy, or removal of the ovaries or testicles, when the organism tends to take on certain character of the opposite sex. This shows that each sex contains potentially certain actualities of the other, and similarly the most highly specialized organism contains

the potentialities of remote ancestral actualities, which display themselves under modifications of cell environment.

"As regards tumours, the nature of this environment is known in certain instances, as in the granulomata: parasites enter the tissue, and so disturb the cell environment that they can no longer maintain their high grade of specialization, and revert in consequence to an ancestral type. The malignant tumours have, I believe, a like parasitic origin; but there is no need here to adduce arguments in favour of this view. Now, sarcomatous tissue is distinctly of an ancestral type: one cannot, however, speak so positively of the carcinomatous. In epithelioma, however, we see changes allied to embryological ones. The squamous epitheliomata originate by an involution of the epithelium, such as occurs in the development of all open glands (even the liver is thus developed); but in this instance the invested cylinders have no lumen; nevertheless, the manner of development is that of a crude form of gland. In the cylindrical variety we have a higher effort, for a distinct lumen is developed. I cannot compare the carcinomata with any embryological or ancestral tissue, through dearth of knowledge; but let us bear in mind that the affected tissues must possess the potentiality of this mode of growth; and whence, it may be asked, have they this power? I should not be surprised if one of wide histological knowledge could throw light upon the subject by studying it on the lines laid down by Dr. Gresswell."

It is certain that such reversions of a mature tissue to an ancestral state play a very important part in pathology; but the subject stands in need of careful investigation. In this connection gout at once occurs to mind. Abnormal quantities of uric acid are produced in this disorder. Now, in certain classes of animals the nitrogen is eliminated chiefly in the form of uric acid, and the question arises whether gout be not such a reversion. It is impossible to say, because we know practically nothing concerning the mode of production of uric acid, and it may turn out that the physiology of uric acid in mammals is fundamentally distinct from that in birds and reptiles. However, this case of gout suggests to us that in many diseases the process of reversion plays an important part. If we bear in mind the countless potentialities of every complex organism — potentialities derived from an untold number of ancestors—we shall be the less inclined to think the suggestion fanciful and unworthy of further investigation.

What can be more interesting than the mode of growth of squamous epithelioma? The process is strictly analogous to the development of tubular glands, but I can have no doubt that the affected tissues in this disease, be the exact nature of the process what it may, display potentialities which in far-off ancestors had, in very large measure, an actual existence. Indeed, it may be said that most, if not all, diseases are tinged with an element of reversion. By this I do not mean that the body in disease reverts, as a whole—that each and all of the tissues take on the exact characters of some particular ancestor—but rather that certain local reversions of the tissues take place. It was just now said that all diseases accompanied by distinct structural change are, without doubt, examples of dissolution. This dissolution being incomplete (for when complete dissolution takes place we are dealing, not with disease, but with death of the part), it necessarily follows that the tissue or tissues which have thus undergone partial dissolution must possess characters which belonged to a past era of evolution. Such local reversion need not be a perfect reversion, as we shall presently see; but that the change must, in some degree, be a reversion, appears to me an *à priori* conclusion.

We must not, however, leave out of account the part played by evolution in the process of disease. Evolution is not unfrequently observed to follow on the structural dissolution, or even to accompany it. Indeed, it is often by no means easy to separate the two processes. Let us instance the process of inflammation, which affords a very good example of local reversion.

It very frequently happens that, as a result of inflammation, the affected tissue is converted into granulation or embryonic tissue. This, in fact, always happens when the process is neither so severe as to completely destroy the tissue, nor so slight as to permit of complete absorption of inflammatory products. Now, granulation-tissue belongs to an order common in lowly and remote forms of ancestral life. It, therefore, follows that, when a mature tissue is replaced by granulation-tissue, it reverts, in the truest sense of the word. The question we have to decide is, how far the process whereby the mature and perfectly evolved tissue has been changed into this

granulation-tissue, is one of dissolution, and how far it is one of evolution. The exact origin of the cells composing granulation-tissue is still a subject of dispute; for, while all pathologists agree that the majority of them are derived from the blood, there is not yet complete agreement as to whether the fixed cells of the affected part help in their formation. Now, if *all* the cells are derived from the blood, we must look upon the process whereby a mature tissue is converted into granulation-tissue as a complete dissolution, followed by a separate and independent evolution; but, if some of the cells, as is probably the case, are derived from the fixed cells of the part undergoing dissolution, it follows that the cells of the affected part are, at one and the same time, undergoing dissolution and evolution; for, while the mature cells are breaking up and thus descending from their high state of evolution, they are, at the same time, giving birth to offspring, and this must be considered as a step in the direction of evolution.

In such a disease as epithelioma, again, it is very difficult to separate the two processes—dissolution and evolution. Let us take the squamous variety. There is a great multiplication of epithelial cells, and, in so far as this multiplication is at the expense of mature cells, there is dissolution. The young progeny, however, grow, or seem to grow, into mature cells. There is, therefore, a more or less complicated *evolution*. But the evolution is not complete; we have seen that the word "structure" does not apply merely to the conformation of individual cells, but also to the arrangement of them into *tissues*, and in squamous epithelioma the arrangement of the cells is imperfect; wherefore, taking the tissue as a whole, it is obvious that evolution is partial.

But it matters little whether we can or cannot, in any given instance of disease, mentally separate the two processes of dissolution and evolution. The important fact for us, at this place, is—that the local evolution in disease, alike with the local dissolution, leads to reversion, or, more accurately, to a series of reversions; for while a cell or tissue is evolving, it must, unless it evolve on lines entirely different from those on which the species itself evolved—a thing obviously impossible—pass through various phases of past ancestral life.

The evolutions of which we are speaking are, for the most part, partial; but a partial evolution is, in some sense, the equivalent of incomplete dissolution, and, in either case, a tissue state is produced which is tinged, more or less, with ancestral characters. In so far, then, as all diseases accompanied by distinct structural change are undoubtedly examples of either partial dissolution or of partial evolution, they may be regarded as local reversions.

Here, however, we have to ask the important question—Are these reversions true? Does the affected tissue take on *exactly* all the characters of some remotely ancestral tissue? It may, I think, be asserted *à priori* that this cannot happen in all cases. In healthy granulation-tissue, we have an example of more or less perfect reversion; but here, be it noted, the cell E is healthy. In all cases of partial dissolution and evolution the cell E is unhealthy. The elements of the tissues are subjected to a species of mal-E unlike any which they have experienced during the long course of their ancestral life. Now, we have seen that E is capable of modifying S, and from this it is obvious that a perfect reversion is quite impossible under a mal-E; for, even supposing, for the sake of argument, such perfect reversion to occur, the altered E would necessarily cause some modification in the truly reverted character. It therefore happens that, in almost all cases of local reversion occurring in disease, the evolutionary or dissolutionary process is not only incomplete, but *erratic*. Wherefore it is more accurate to style these reversions "local vitiated reversions."

CHAPTER XIII.

Heredity (*continued*)—A Consideration of the Different Modes by which Organic Potentialities may become Actualities—Some further Bearings of the Principle of Reversion upon Pathology—Summary.

Potentiality.—Allusion has been made more than once to that curious property termed potentiality. This property is possessed by living aggregates in common with other aggregations of matter; here, it is only necessary for us to speak of the potentialities of living organisms. A property is said to exist potentially when it is not actually present, but is capable, under certain circumstances, of being called into actual being.

I am led to consider this subject here, because the partial dissolutions and evolutions of which we have just spoken afford very good examples of the way in which potentialities may become actualities. There are, however, other ways in which this may take place.

In treating of the causes of potential manifestations, I shall consider the individual and not the race: the reappearance of a long-lost ancestral character in the offspring of crossed parents may be said to pertain rather to the race than the individual, seeing that it is not so much the manifestation of a potentiality by an individual, as of parental potentialities.

Confining our attention, then, to the individual, we shall find that there are at least four causes of potential manifestations:—

1. Partial dissolutions of disease.
2. Partial evolutions of disease.
3. Normal organic evolutions.
4. Interference with the proper action of ovaries or testicles.

1. The partial dissolutions of disease affords a particularly good example of the manner in which a potentiality may become

an actuality; for it is, as we have seen, in large measure, an inverted evolution, and when a structure is taken to pieces in the inverse order to that in which it was put together, there are necessarily revealed characters which belonged to the individual at successive periods of his evolution. Characters which were before potential now become actual. This method of potential manifestation may be illustrated very simply. At a certain stage in the building, or evolution, of a house, before the roof has been put on or the windows fixed, it will be both draughty and, in rainy weather, wet; but when the house is finished—when its evolution is complete—it will, if properly constructed, become perfectly dry and free from draughts. If, now, we invert the evolution, and cause a partial dissolution by removing the roof and taking out the windows, the house will again display characters which belonged to it at a certain stage of its evolutionary career: it will become once more damp and draughty. Characters, before potential only, now become actual.

Yet another example may be given. The process of evolution may be observed in the invention and gradual improvement, during the long course of years, of a machine, until, finally, perfection is reached—that is to say, the highest possible pitch of adequacy. Owing to the enormous competition between different machines, belonging, as we may say, to the same species, there is a struggle among them for existence, and this struggle will eventuate in the survival of the fittest. Every new improvement is, as it were, a happy variation, which will be seized upon by the market, which constitutes, so to speak, the environment; and thus, by an accumulation of improvements (natural variations), perfection is at length attained. It is true that, as the evolution proceeds, there is not necessarily an increased aggregation of matter, nor a greater complexity of structure, for sometimes a great improvement may be made by simplifying the structure and diminishing the bulk, and in such cases the various phases in evolution would not fulfil the terms of Spencer's formula. But this is simply because that artificial evolution which is the product of man's mind, is less orderly and perfect in its progress than the unconscious evolution which is ever at work throughout Nature. It not unfrequently

happens, however, that the evolution displayed in the history of a machine fulfils the terms of Spencer's formula, many machines being improved by successive additions, whereby the structure becomes more "integrated" and more complex (heterogeneous).

Let us now suppose that some particular machine has been thus very much improved by some slight addition to its structure. It will contain potentially the ability to work in the old-fashioned manner; for, if the recent addition be removed, a partial dissolution being thus effected, this potentiality will be manifested.

2. The incomplete local evolutions which take place in disease afford another example of the conversion of *potentialities* into *actualities*, for it is obvious that, in this process, the affected tissues take on characters which they did not possess before.

Both in partial evolution and partial dissolution the process, as we have seen, is often, indeed generally, vitiated; and it therefore by no means follows that when the potentiality becomes manifested by either of these methods, such potentiality has ever existed as a normal actuality in the ancestral history of the individual; for, owing to the action of E upon S, the S will cause, so to speak, natural variations in the partially evolved or dissolved tissue. Nevertheless, such structural characters must have existed potentially in the tissues. Thus, the tissues contain myriads of potentialities, many of which never have been nor ever will be manifested, for, to suppose that every potentiality has been manifested, is to suppose that the tissues have been subjected to every conceivable form of E, seeing that every different form of E is capable of affecting the tissues in a different way.

3. In both the methods already given, the potentiality becomes an actuality by the local falling away in the evolutionary value of a mature tissue. An actuality, before only latent, may, however, also be developed by an *advance in evolution*. Thus, an embryo contains all the potentialities of the future individual. Of this method little need be said. Many such potentialities are displayed in the natural and, so to speak, unaided process of evolution, and many may be developed by a special education; indeed, it often happens that

an individual is potentially endowed with qualities whereof he and his friends are wholly ignorant. Undeveloped heroes—"village Hampdens"—are, perhaps, more common than most people imagine; certain it is that great crises call into prominence men who would otherwise have passed their lives in obscurity, and some historians would perhaps class Cromwell among their number. It often falls to the duty of the physician to develop potentialities by this process of evolution; for he is not infrequently able to render an individual proof against some particular disorder by favouring the evolution of certain tissue or tissues—such as the tissues whereof the nervous system is built.

4. Finally, a potentiality may be converted into an actuality by disease, atrophy, or removal of the ovaries or testicles, for, under these circumstances, each sex tends to take on certain of the proper sexual characters of the opposite sex. Pathologically this fact has its importance, for, when the ovaries remain long inactive, the woman tends to become masculine—probably owing to an atrophy of these organs from disuse, and this more notably occurs after the menopause. In so far as sex is capable of colouring disease, we shall accordingly find these modifications in the sexual characteristics giving a corresponding colour to the diseases from which the individual thus sexually altered suffers.

Let us now consider what further bearing the principle of reversion has upon pathology. In treating of the fixity of structural characters, we saw that the *vis medicatrix* rested upon the principle of reversion. But this principle has further application in pathology. In the first place, it is manifest that a reversion may be both pathological and physiological. The latter variety is the most common. As an example of such physiological variation we may again instance the reversion in a fancy pigeon to the blue plumage of its far-off ancestor, the Rock pigeon. We have seen, however, that reversion may occur to a condition which, though normal to the ancestor from whom it is derived, is abnormal to the individual in whom it reverts, as when a branchial cleft persists in a mammal. The latter then is, in one sense, a pathological reversion.

The question now arises, may reversion occur to a condition which from the beginning has been pathological?—may, in other words, an individual inherit a disease from a remote ancestor—*e.g.*, gout, rheumatism, or insanity? Diseases are, as we have seen, pathological variations; and why, it may be asked, should not an individual tend to revert to a pathological, quite as much as to a physiological, state? A little consideration will show that the tendency to revert to the diseased state of a remote ancestor is infinitely less than to revert towards a physiological state. We saw that a pathological variation must necessarily have a much looser hold upon a race than one that is physiological, for such variations are, owing to a survival of the fittest, being continually weeded out. Total extinction inevitably prevents them from being handed along many generations of a particular family line; therefore they never leave a deep impress upon the organism, and, after they have been dropped for a few generations, we may expect this impress to have completely faded away. We saw that certain minor ills that do not endanger life may obtain a firmer hold, and therefore we should expect a greater tendency towards a reversion to such. Reversions to pathological states belonging to a few generations back may, of course, occur; but it is highly improbable—indeed I should say absolutely impossible—for them to occur to a pathological state of such far-off ancestral date as may happen in the case of reversions to physiological states. The stripes of the mule are derived from a very remote ancestor, but then they were a constant ancestral character during many thousands of generations, and made a correspondingly deep impress upon the organism and its embryological processes. No pathological character could acquire such a hold. These considerations should tend to dispose of the theory that many sporadic diseases are reversions to such remote pathological states. (It has been suggested, for instance, that leprosy sporadically occurring in non-leprous countries has such an origin.)

Nevertheless, I see theoretical grounds for assuming that disease *may* result from reversion to a remote ancestral state. Thus, the tissues may revert to remote ancestral states, which, though perfectly physiological in themselves, may be injuriously susceptible to influences which are incapable of hurting the

normally evolved tissues—that is to say, although reversions to remotely ancestral pathological states are improbable, yet reversions to physiological states of a bygone era may lead to pathological states under our present E. We must, however, allow that reversions to true-pathological states of a few generations back are quite possible; and this fact alone should guard us against asserting that a disease has no element of heredity in it when we can get no history of its heredity, for, as Sir James Paget observes, it is impossible, in the most fortunate cases, to trace the family history beyond five generations.

The tendency to reversion when two animals are crossed has, I believe, an interesting application in pathology. We may, I think, safely infer from this principle that the more unlike any two individuals are, the greater will be the tendency towards a reversion in the offspring of their union; nay, I believe we may go further than this, and expect that, if the parents show a great unlikeness in any one particular, there will be a special tendency to a reversion as regards that particular.

Now, if by thus uniting individuals showing great unlikeness in one particular we can effect a reversion to a *status quo ante*, might we not hope, by judiciously mating an individual showing a strong tendency to a particular disease, to cause by reversion a complete disappearance of this in the offspring? Not that I am sanguine enough to suppose that men and women will ever trouble themselves very much about such very unromantic considerations, but it occasionally falls to the lot of the physician to advise as to the desirability of a particular marriage, and it behoves him, therefore, to consider all the aspects of the case. All will admit that nothing could justify assent to marriage between individuals showing a tendency to a serious disease, say *insanity;* but should we be altogether justified in withholding our sanction if one of the two showed a clean ancestral chart as regards that disease? I know many physicians regard the probability of the disorder appearing in some of the offspring of such a couple as very strong, and they are ready to cite several cases in which insanity was inherited from one side only. But, it may be retorted: What proof is there that the other ancestral line is perfectly free from insanity, or some allied neurosis? Of how few families could this

be truthfully said? Modern civilization has wrought the nervous system into a high state of instability. Hence, in the union of an individual having a tendency to insanity with an average individual, the combining tendencies would be more or less in the same direction. Evolution in the case of each having proceeded quite recently upon lines more or less identical, there will be no sharp divergence as regards the nervous system. I hold, nevertheless, that the offspring would show a strong tendency to reversion if the non-affected parent presented a perfectly vigorous and stable nervous system; and I should not consider this position false, without the strongest evidence, in any supposed instance of the contrary, of this parental perfection. The sole crucial test would be the union of a highly neurotic individual with a healthy savage. Let it be noted, however, I do not for one moment assert that there would be *no* tendency in such a case to the inheritance of the weakness. Brown-Séquard's experiments on guinea pigs would at once disprove any such assertion.

I imagine that this tendency of "crossing" to produce a *status quo ante* plays an important part in the inheritance of disease, and may help to explain how the same intensity of the same disease in the one parent is in a certain number of cases strongly inherited, but in others absolutely uninherited. For this frequently occurs, and leads one to think that the principle of heredity is very fickle.

The following case illustrates this point: A. suffered from ichthyosis inherited through his father's side. He married twice. The children by his first wife were quite free from the complaint. Those by his second wife—three in number—were all afflicted with it. It is manifest that the integumental system in the first wife, or some tissue or tissues governing it, prevented the inheritance of the defect. Therefore, putting aside all theory, we have distinct evidence that certain crossings are capable of diminishing the inheritance of a particular disease; and it would, indeed, be a great triumph if we could discover what particular order of constitution is capable of weakening or obliterating, on this principle of crossing, the inheritableness of different diseases—if we knew, for instance, what body-habit would prevent rheumatism in the

mother from being inherited. That there are hidden principles capable of such practical application, I doubt not; but it would need one endowed with the genius and thoroughness of a Darwin to discover them, and, even if we could discover them, they would be of little practical use, for how many young marriageable folk would listen to our words of wisdom?

To sum up the chief points regarding reversion, so far as they bear upon practical medicine:—

1. Reversions to serious pathological states rarely occur, because the graver forms of disease have no great ancestral age.

2. Reversions to physiological states may occur under certain conditions of E and as a result of particular crossings. These may be physiological in the reverting individual, as in the ancestor from whom they are derived; or it may happen that the physiological characters show a tendency to become pathological in the reverting individual, through their imperfect adaptation to modern environments (=sub-pathological variations); or, finally, these originally physiological characters may be distinctly pathological in the reverting individual, as in persistent branchial clefts.

3. The principle of reversion explains the *vis medicatrix naturæ.* This is favoured by subjecting the individual to an environment as like as possible to that of primitive man; or, by crossing an individual showing a disease-tendency with one showing a character very unlike the pathological one, on the principle that crossing of unlike individuals tends to a reversion to the *status quo ante* the development of the unlike points, namely, health.

4. Most, if not all, diseases are attended by or rather, consist in, a multitude of reversions, for, in so far as the structural alterations of disease are partial dissolutions, they must in some degree be reversions; for a partial dissolution must necessarily tend to disclose a tissue state belonging to a past evolutionary era.

CHAPTER XIV.

Heredity (*continued*)—Influence of the Male Element upon the Female Organism—Inheritance of Acquired Structural Characters.

Influence of the Male Element upon the Female Organism.—It is well known that the sperm not only affects the germ or the female element, impressing upon it the power of growing up into a more or less mean parental likeness, but that it likewise influences the mother organism. This holds good both of plants and animals. Thus, in plants, the ovarium and the contents of the ovule, which "are obviously parts of the female organism,"* and quite distinct from the embryo, are frequently affected by the male element—the most common alteration being one of colour. This is best shown by fertilizing the flowers of one species with the pollen of a different species or variety, when it is found that "sometimes the whole ovarium, or all the seeds, are thus affected, sometimes only a certain number of the seeds. . . . . If we could imagine the same flower to yield seeds during successive years, then it would not be very surprising that the flower of which the ovarium had been modified by foreign pollen, should next year produce, when self-fertilized, offspring modified by the previous male influence." Similarly in the case of animals. The mother is in some way influenced by the male element, so that future progeny by another father tend to partake of the characters of the former sire. Thus, a thoroughbred mare was crossed with a quagga, and bore to it a hybrid animal; this same mare was afterwards crossed with a black Arabian horse, and produced two colts, which were more plainly striped than the quagga; "but what makes the case still more striking is the fact that in these two colts the hair of the mane resembled that of the

* See "Animals and Plants under Domestication," vol. i. p. 428, second edit.

quagga, being short, stiff, and upright." * Many such cases might be cited, but there is no need, for the principle in question is so well recognized that no breeder would allow a good animal to be crossed by one of inferior breed, for fear of damaging the future progeny.

Now, these considerations raise a question of some interest to the physician. If the male, by impregnating the female, tends to make all the future progeny like himself, one would expect the second child of the same parents to be more like the father than the first, for it would inherit the ordinary mean likeness *plus* an additional degree of likeness derived from the previous impregnation, and this latter we may suppose to increase with each successive impregnation by the same male; so that, if such is the case, each successive child should be more like the father, and in consequence show a greater tendency to inherit disease from him. Whether this inference is true or not, I cannot say, but the subject is one deserving of investigation, and I should be somewhat surprised were it not found that the first child is, on the whole, least like the father; but I should not be surprised if it were discovered that, after the second, each successive child was not more like the father, because we can well imagine that the sire, having once, by an impregnation, influenced the mother in a particular way, may be incapable of adding to this influence by subsequent impregnations. There is no reason why the question should not be settled by a series of experiments on animals and plants.

Inheritance of Acquired Structural Characters.—Of course characters once acquired tend to be inherited. Some authors—even great ones—have been at much trouble to prove that acquired characters, as well as inherited ones, may be handed down by parents to their offspring. To me the fact seems self-evident; it matters little how a parent has come by a character, for, according to the great doctrine of heredity, the offspring *tend* to reproduce more or less *exactly* the likeness of the parents. What we have seen is, that acquired characters are less likely to be inherited than others, for they are not so deeply impressed upon the organism.

* "Animals and Plants under Domestication," vol. i. p. 436.

Some very interesting instances of the inheritance of acquired characters are on record. Quite recently the *Lancet* recorded the case of a bitch transmitting to one of its pups a peculiar trick which it had learnt. The pup was removed from its mother while very young, so that the case cannot be explained on the theory of imitation. Similar instances might be recorded by the score.

There are also on record many cases of the inheritance of obvious tissue-alterations wrought by violent means. Thus, a cow, which had lost a horn from "accident and consequent suppuration," produced three calves which were hornless on the corresponding side, and it is well known that mutilations in man are apt to be inherited, as has happened with injury of the eyes, face, hand, fingers, and other organs. Again, the effects of operations are sometimes inherited: thus, the epilepsy which Brown-Séquard produced artificially in some guinea-pigs by section of the sciatic nerve and injury of the cord, was transmitted to their offspring. The following conditions, artificially induced in the parents, were also transmitted: absence of two or three toes in the hind leg, exophthalmia, hæmaturia, and dry gangrene of the ears. It is noteworthy that in all these operations the nervous system was markedly involved in the injury; wherefore, this system has been assumed to play an important part in such inheritances.

On the other hand, mutilations may be inflicted upon several successive generations without showing the slightest tendency to inheritance. Many savage tribes mutilate their bodies in sundry ways, but, so far as we know, such mutilations are never inherited. Moreover, the practice of circumcision, which has been followed for many generations by the Jews, seems to have left no permanent effect upon the race.

All this shows us that we have yet much to learn concerning heredity. Yet there can be no doubt that the subtlest changes wrought upon an organism by peculiarities of E tend to be inherited. There is not an act or thought of a parent but may have its effect upon the offspring. What tremendous responsibilities, therefore, rest upon fathers and mothers! The individual is an embodiment of the hereditary principle. What he is, such future generations springing from him will

tend to be, for none of us can escape the inexorable law of heredity. Though the influence of the Environment is great, it may truly be said that we are what we are—great or small, strong or weak—by virtue of heredity. But we have the power to make ourselves better or worse. Wherefore, let every potential parent remember that the strengthening or weakening of his structure not only concerns himself, but those who come after him—that his conduct of life may, in other ways than by example and intellectual legacy, echo through posterity.

Seeing that disease is an abnormal inter-action of S and E, and that S is almost entirely determined by heredity, it is manifest that heredity must take an overwhelming share in the causation of disease. But we shall the better be able to appreciate this fact after certain other topics have been considered, and, therefore, the part played by heredity in disease will be considered separately (see Part III).

CHAPTER XV.

The Causation of Structure—The Influence of Ante-partem Environment upon Structure.

Having now firmly grasped the fact that the structure of an organism chiefly depends upon heredity, and that, compared with it, any other moulding power is altogether insignificant, we have now to study more particularly the part which E plays in moulding the organism.

Although its influence is infinitely less than that of heredity, it is nevertheless capable of profoundly modifying structure, and its effects are deserving of most careful study.

I have endeavoured hitherto to keep the treatment of these two great plastic powers as far as possible apart, for the sake of clearness, but it has not been possible to succeed in this entirely.

The influence of E disturbs heredity. Were the E exactly alike for every child born to the same parents, all the children would be exactly alike, save, of course, for such differences as depend upon sex: that is to say, the sons would exactly resemble each other, and the daughters likewise. And if the world were peopled afresh from another Adam and Eve under an identical E for all, all men on the one hand and all women on the other, would be exactly alike at corresponding ages.

This proposition may seem a bold one, but I shall bring forward strong evidence in support of it. Should, however, the reader deem this evidence inconclusive, the hypothesis will, nevertheless, be found to be a good working one. To me the conclusion seems so tempting, that I am surprised biologists have not embraced it eagerly. Perhaps some have actually done so, but certainly neither Darwin nor Spencer have committed themselves to it, although the latter philosopher, by implication at least, would almost seem to hold the view.

It is obvious that such a proposition can admit of no experimental proof. How is it possible to subject any two brothers or sisters to exactly the same E from the earliest period of their existence, the E, it must be remembered extending back beyond the period of embryonic life to the actual coming into being of germ and sperm? But, although our proposition admits of no absolute experimental proof, neither does the first law of motion. The two, indeed, allow of the same kind of proof—namely, that termed by logicians the "method of residues." The first law of motion runs thus: "A body in motion will continue to move with the same velocity in a straight line for ever, if no other force than that by which it is impelled act upon it." But the conditions of the "if" obtain nowhere. Nowhere is it possible to isolate a body from the action of other forces; the tiniest fleck acts upon, and is acted upon by, every other particle of matter in the universe, however remote it be. He who denies this must be prepared to confute the law of universal gravitation. It is found, however, that the nearer the conditions of the "if" are approached, the closer does the result accord with the terms of the proposition. In our own world, friction and atmospheric resistance are ever present to counteract the tendency of the first law of motion, but such outside resisting forces are reduced to a minimum in the case of the heavenly bodies, which, suffering practically no resistance, maintain a more or less uniform rate of movement; nevertheless, the motion is not in a uniform straight line, for gravity still acts, causing the movements in curves, and maintaining each system in "moving equilibrium."*

The same line of argument applies to heredity: the nearer the requirements of the case are complied with, the closer do we find the result according with the assertion. In both cases we have to deal with an E which represents the conditions of the "if;" in the one, we require a completely negative E, and in the other an E which shall be alike for all the children born of the same parents, and it is, as I have said, manifestly impossible to obtain either of these requisites.

* The truth of the principle, however, is placed beyond the possibility of confutation by the fact that it forms a correct basis for astronomical calculation.

The impossibility of any two organisms being subjected to exactly the same E is evident from Herbert Spencer's dictum, that "no two parts of any aggregate can be similarly conditioned in respect of incident forces." * So that even unicellular organisms inhabiting the same fluid medium cannot be subjected to exactly the same E; and not only this, but no two parts of any *one* organism "are similarly circumstanced in respect of incident forces."

Hence different organisms, being subjected to forces which are more or less unlike, tend themselves to become more or less unlike—that is to say, they form natural variations, and not only does the organism as a whole alter, but owing to different parts of the same organism being subjected to different forces, the structure of these different parts becomes differently modified: the homogeneous passes into the heterogeneous. Now if the E can never be the same even for simple organisms, we see how utterly impossible it is that it should be the same for such a complex organism as man.

The Influence of the Ante-partem E upon S.—Let us, for instance, consider briefly man's ante-partem E. In so doing, it will be necessary, of course, to start at a period antecedent to the birth of germ and sperm, and to inquire into the conditions under which they come into being; and it will be further necessary to take account of the agencies environing the embryo to which they give origin. Concerning the former, it is manifest that the circumstances under which germ and sperm spring into being, and the subsequent E of each, must differ from time to time with the general bodily health of the father and mother, with the kind of food taken, the amount of physical exercise, and so forth. We can well understand how these and other conditions, many quite outside our knowledge, may so modify the cell-E of the tissues, including those of ovary and testicle, as to lead to differences in their cell structure—to deviations, that is, from the ideal form—and, consequently, to differences in the reproductive elements to which these latter structures give origin. Even supposing, however, the bodily state of the parents to be exactly the same from day

* See Spencer's "First Principles," § 109. Also Spencer's "Biology," vol. i. § 88.

K

to day and year to year, it would follow, from the Spencerian dictum above quoted, that no two germs or sperms could be exactly alike, for it is utterly impossible for the conditions of birth to be exactly alike in any two cases; but, inasmuch as the bodily state does vary from day to day and from year to year, we should expect those germs and sperms to be most alike which are produced at or about the same time, for in such cases the conditions of germ and sperm birth are most alike; and this, as we shall see, is the case.*

We have next to take into account the influence of the E upon the embryo during the months of gestation. This, though very important, is far less so than the earlier influence just spoken of. It is wrought in a twofold way, and in a twofold way only—(1) Through the mother's blood; (2) Through modifications of external pressure. Such being the case, one is induced *à priori* to doubt the popular notions concerning maternal impressions.† Dr. R. Lee believes that many cases of idiocy are caused by mental distress in the mother whilst with child, and it is noteworthy that from time immemorial men have attributed great influence to the woman's surroundings while pregnant. Thus, in some countries, curious objects are placed about the chamber, and are supposed, by working on the mother's mind, to influence her offspring. All will certainly agree that the mind of the pregnant woman should be kept in a quiet and composed state, but this is chiefly for her own sake, for the emotional being of the pregnant woman

* In connection with this subject the reader may recall the opening words of "Tristram Shandy":—"I wish either my father, or my mother, or, indeed, both of them, as they were in duty both equally bound to it, had minded what they were about when they begot me; had they duly considered how much depended upon what they were then doing; that not only the production of a rational being was concerned in it, but that possibly the happy formation and temperament of his body, perhaps his genius and the very cast of his mind; and, for aught they knew to the contrary, even the fortunes of his whole house might take their turn from the humours and dispositions that were then uppermost. Had they duly weighed and considered all this and proceeded accordingly, I am verily persuaded I should have made quite a different figure on the whole from that in which the reader is likely to see me. *Believe me, good folk, this not so inconsiderable a thing as many of you may think it.*"—LAURENCE STERNE.

† For a *résumé* of the main facts connected with this subject see Dr. Fordyce Barker, "American Gynæcological Trans.," 1887.

is wrought into a high pitch of irritability. Every tissue in her body is, in fact, at this time, modified, and the nervous system forms no exception. Wherefore it happens that depressing mental shocks are doubly apt to depress the pregnant woman, and thus the mother's health suffers, and through it that of the child. The effect on the latter is probably wrought through the mother's blood, which must necessarily suffer from any great disturbance in nervous action. Owing to this irritable state of the nervous system in the pregnant woman, it rarely happens that she passes through the period of child-carrying without some fright or trouble, so that little difficulty is found by believers in maternal impressions in accounting for any peculiarity in the child that may happen to be present.

Although it is not easy to conceive of any other ways by which the mother can impress her child, it is, of course, open for any one to assert that there are unknown agencies—powers quite beyond the reach of discovery—capable of bringing about this result; and, however improbable such a view may seem to us, we are not justified in rejecting it unless we can prove that certain results can be explained on either of the methods mentioned.

Let us first inquire how the child may be influenced through the mother's blood. A rich and abundant supply of blood—and the quantity will chiefly depend upon the size of the placenta—will necessarily lead to a larger and better nourished fœtus than one that is poor and scanty. We may be quite sure that this early difference in blood-supply will leave an impress upon the embryo which will be felt throughout the whole ensuing life. No matter how perfect the post-partem environment, it cannot compensate for such an imperfect blood-supply. If the foundation of the young human being be not properly laid, it is impossible to erect thereon a solid, well-built structure; patch it up as we may, the fundamental weakness will be for ever showing itself. In regard to the nature of the mother's blood we must remember, however, that the fœtus is, in some respects, a parasite upon the mother, and will appropriate the nutritive elements of the maternal blood far more vigorously and abundantly, relatively to its size, than the mother; so that an intensely emaciated

mother may bring forth a stout child; but mere bulk is not a sign of excellence, and we must not too hastily assume from such a case that the state of the maternal nutrition can have little influence on the child. There cannot be the slightest doubt that the general state of the mother's health, by determining the quality of her blood, works a marked effect upon the destiny of the child.

The mother's blood may likewise affect the fœtus by containing some poison, such as the virus of syphilis or scarlatina.

It is difficult to see how the maternal blood can influence the fœtus, except in one of the three ways just mentioned—namely, by being abundant or scanty; rich or poor in its proper constituents; or, finally, by containing some noxa. It is not easy to understand how it can convey an impression from a particular tissue in the mother to a corresponding one in the fœtus, as must occur (if there be any truth in such cases) when the mother having, let us say, been struck during pregnancy across the face with a rat, the child is born with a mark corresponding exactly in position. I repeat, one cannot well see how the mother's blood can influence the child so as to bring about such a result. If the maternal impression occur before the complete development of the ovum, the explanation is easy: the tendency of the ovum is to reproduce the structure of the mother. Such is the law of heredity. Therefore, if the mother's body undergoes some change in structure before the ovum has ripened (and this takes place just before conception), the child would tend to inherit it; and that mental shocks may work a specific effect upon particular tissues, there can be no doubt. For instance, a woman sees the foot of a child crushed under a gate, and she is forthwith seized with great pain in her own foot, and this afterwards becomes actually diseased.* Such a local change might so impress the ovum as to lead to a peculiarity in the corresponding foot of the fœtus developing therefrom. Indeed, this might well occur, even though the mother's foot were not *obviously* affected; for, supposing the doctrine of Pangenesis to be correct, one can understand how the maternal blood

* See on this subject Tuke's interesting work on the influence of the mind on the body.

might convey specific influences from certain maternal tissues to corresponding parts in the child, the "gemmules" thrown off from such maternal tissues would, according to this doctrine, show a tendency, by their inherent attractive power, to attach themselves to corresponding parts in the child, and so influence the development of these parts. But this is obviously sheer speculation.

The second and sole remaining method by which the fœtus may be affected is by pressure. It is well known that all sorts of mutilations may result in this way, and it is needless to enumerate them. Possibly the shape of the child's head may in some degree depend upon the shape of the mother's pelvis, for the moulding of the head at birth is probably never entirely recovered from; and thus it may happen that the different kinds of presentation permanently influence the shape of the head by moulding it in different ways, so that a head, born for instance by breech, may be permanently different in shape from what it would have been had it been born by vertex. As showing the influence of pressure upon the shape of the head, it may be remembered that some savage tribes alter the shape thereof by pressure between boards; nevertheless, the compression which they employ extends over a prolonged period, differing very markedly in this respect from the merely temporary pressure of birth.*

* It may be remarked here that the shape of the child's head bears a definite relation to that of the female pelvis. This may be seen by examining the pelves and crania of the different races of man. The two have become mutually adapted to one another, and the adaptation has doubtless been largely wrought by natural selection. On the one hand, any variation in the shape of the head which hindered its birth would tend to the destruction of the child. Hence the shape of the pelvis doubtless largely determines that of the child's head, because in a state of nature, at all events, only those heads are born which are properly adapted to the pelvis. On the other hand, if the pelvis does not properly admit of the passage of the child's head, the mother would be more apt to die, so that natural selection maintains the proper adaptation of the pelvis to the shape of the head; wherefore the shape of the fœtal head likewise determines that of the maternal pelvis. Now, the main distinction between the male and female pelvis is undoubtedly the width of the pubic arch. Almost all the other differences follow from it, as I have proved to myself on a soft artificial pelvis; for if the tuber ischii be pulled outwards, the arch widens, the symphysis and the pelvic cavity become shallower, the thyroid foramina triangular, and the transverse

I. Geoffroy St. Hilaire has made several important experiments upon the lower animals, with a view to study the effect of ante-partem E upon the offspring. His writings should be carefully studied by those wishing to work in this direction.*

It is proper here to allude to the effect of premature birth upon the child's future. When the fœtus is born before its time, the E undergoes a sudden and premature alteration. In place of the uniformly warm medium afforded by the amniotic fluid, it is prematurely subjected to the vicissitudes of temperature. This may be more or less successfully guarded against; more important is the premature substitution of feeding by mouth, for nourishment drawn directly from the mother's blood. The child has now to elaborate for itself the blood which hitherto has been conveyed to it through the placenta, and, its digestive system not yet being prepared to properly digest the mother's milk, it cannot possibly be so well nourished as by the placental blood. Hence, every prematurely born individual is less vigorous than he would have been if born at the full time.

From what I have said it is manifest that the ante-partem E is no such simple thing as some might think. There is, indeed,

diameters increase. The only other important distinction between the male and female pelvis, which cannot thus be accounted for, is the greater conjugate in the female. Now the advantage to woman of this widening of the pubic arch is obvious. In all vertex or face presentations, the part to be born first, namely, the occiput or chin, rotates, or should rotate, under the symphysis. If either of these parts are from the first anterior (as is the rule), the depth of the bony pelvis through which they have to pass is very small, to wit: the depth of the symphysis pubis. Thus they are readily pushed out under the arch, one end of the long pole being thereby released, and, if the arch be wide, birth of the remaining part of the head readily occurs. In rarer cases backward rotation takes place; but mark the difference —the part to be born first has to travel through three times the distance of bony pelvis, and, further, it does not pass under an *arch*, but over a sharp point. The width of the arch, therefore, stands in a most important relation to the child's head. The larger the latter the greater is the necessary pubic span, so that we should expect the female pubic span to be largest in those races which are the most intellectual. Now the width of the pubic arch determines the width of the hips, for, as the arch increases, the acetabula, and with them the femora, are thrust outwards. Wherefore we may conclude that the women of intellectual races are large-hipped, and that, as evolution proceeds, they will become more so. These theoretic considerations are, I believe, substantiated by fact.

* *Vide* "Mémoire sur la Production Artificielle des Monstruosités, 1862," pp. 8–12; "Recherches sur les Conditions, &c., chez les Monstres," 1863.

a wide field of study here. We have seen that the spermatic and germatic E cannot possibly be the same for any two germs or sperms, and we have further seen that the embryonic E is capable of much diversity, and that the nature of this E exercises an important influence on the destinies of the individual, though one far less than that of the earlier germatic and spermatic E. And here we may enunciate an important principle, namely: *the influence of E is great in proportion as it acts early in the life-history of the individual.* It is most potent during the evolution of germ and sperm: it is more potent during the earlier than during the later periods of embryonic life: and after birth its influence grows less and less, as time wears on, the diminution being most marked after maturity has been reached; for the E is then incapable of interfering with development.

The above principle follows from the fact that a small initial difference will, in the course of time, lead to a very wide deviation. In the germ and sperm, how inconceivably complex must be the arrangement of the ultimate particles, and how important, at this early date, the influence of the E upon their delicate fabric! We can well see how the slightest dislocation of the ultimate germ and sperm particles will modify the entire future development of the embryo to which these two elements give origin; and when we further reflect upon the rapid and important changes occurring during the earlier period of embryonic life, it is not difficult to understand how influential the E is at this time in directing the processes of development in this or that direction.

Inasmuch, then, as the ante-partem E differs for different individuals, it follows that all children born to the same parents must differ, for a difference of E necessitates a difference of structure. According to our principle of structural mean, all children born to the same parents would be the same under exactly the same E, save, of course, for such differences as depend upon sex. But variations become an *à priori* necessity from the diversities of E. The only point about which doubt can exist is whether this diversity of E is competent to account for all the differences.

Now it is a very suggestive fact that the more nearly identical the ante-partem E, the more alike are the children. The nearest approach to identity occurs in the case of twins, and these, as every one knows, are more like one another than brothers and sisters not of twin birth. The germs and sperms from which twins are evolved have sprung into being under very similar conditions, and the E, moreover, of the embryos, as determined by blood, is very similar. As regards quality of blood, it is practically the same, but the quantity may, of course, differ, as when the placentæ are not of the same size; and as regards pressure, the effect upon the two children may be very different. Thus, even in the case of twins, some structural differences may be *à priori* postulated; sometimes the difference is considerable. Professor Lucas, whose work on Heredity, so far as it is a record of facts, is the most important one yet published, quotes from Pierre Beielly: * "Twins differ in expression, voice, writing, gesture, carriage, and in many other respects. . . . The Siamese brothers themselves—these more-than-twin beings—were not of the same height, and the truly striking likeness of countenance showed a marked difference on close study." . . . "A similar diversity is met with among the young of animals," continues Dr. Lucas; "the difference among the pups of the same litter, even when one has taken care to cross the bitch with the one dog is often prodigious." Herbert Spencer speaks in a like strain: "Plants grown from seeds out of one pod, and animals produced at one birth are not alike, and sometimes differ considerably. In a litter of pigs or of kittens, we rarely see uniformity of markings, and occasionally there are important structural contrasts. I have, myself, recently been shown a litter of Newfoundland puppies, some of which had four digits to their feet, while in others there was present on each hind foot what is called the 'Dew claw,' a rudimentary fifth digit." †

Some diversity among offspring born at the same time is an *à priori* necessity, as I have again and again insisted. No two peas from the same pod, nor any two members of the same litter

* "Traité de L'Hérédité Naturelle." Par le Dr. Prosper Lucas, vol. i. p. 105.
† Herbert Spencer, "Principles of Biology," vol. i. § 86.

or brood, are "similarly circumstanced in respect of incident forces," and therefore they must differ. Nevertheless, plants grown from the seeds out of one pod, and animals produced at one birth, are more like one another than plants grown from the seeds of pods produced at different times, and animals produced at different litters. The only remaining question is, whether the differences in E are adequate to account for the differences of the individuals? The fact that among animals born at one birth, some may take after the father and others after the mother, is an apparent argument against the principle for which I am contending, but one can well understand how the nature of the E under which germ and sperm spring into existence may so affect their delicate structure as to strengthen or weaken, as the case may be, the capacity of the one or the other to cause the offspring to grow like the being from which it is derived.

The remarkable likeness between human twins is nowhere better shown than in the tendency which they display towards the same diseases; it proves that they are like one another, not only in gross configuration, but also in the more delicate structure of the tissues. I shall have occasion in another part to speak of the pathological likeness of twins. Here I will briefly mention two cases. A mother brought her twin babies to me. Each of them was suffering from a syphilitic rash of like character and distribution; considering how varied are the rashes met with in congenital syphilis, this likeness was remarkable. The eruption appeared when the children were three weeks old, in the one a few hours before the other. Each child having developed under an almost identical E, not only in respect of physiological conditions, but in respect also of the specific mal-environment, what wonder that they should exhibit this marvellous pathological likeness! Again, I have, the very day I write this, seen twin girls, of whom the mother says: "They are always ill together; the one never suffers without the other."

CHAPTER XVI.

The Influence of Environment upon Structure—The Influence of the Ante-partem Environment (*continued*)—Differences in E the Prime Cause of Natural Variations.

We have already seen that the E is not so effective after birth as before it. Nevertheless, from a health point of view, it is of far greater importance, because there is greater room for morbid influences after birth, when the E abounds in evils. Moreover, before birth the organism is, in a sense, parasitic, but after birth it becomes independent and capable of regulating its own E.

Indeed, although the post-partem E is less able to influence S than the ante-partem E, owing to the great plasticity of the embryo, it is nevertheless a fact that the post-partem E is capable of inducing very considerable structural change, the growing complexity of the E as the individual waxes older being to some extent a set-off against the lessening plasticity of his tissues. If the E of different individuals must be unlike before birth, how much more unlike must it be *after* birth! The complexity and necessary diversity of the post-partem E was insisted on in a former chapter. We there saw how, in a complex society, the number of different E's increases as the division of labour proceeds, for the E differs in every occupation. And thus it happens that, if all people came from their mother's womb exactly alike, they would soon begin to differ in a recognizable way. Let one of twins become a soldier, the other a shoemaker, and we shall have no difficulty in telling the one from the other, no matter how great their original likeness. And not only will they be altered in obvious bodily structure, but a careful look into the mental world of each will disclose a marked difference there also. Thus do our surroundings mould

us. The plastic being is shaped by the E in all sorts of different ways, both as regards mind and body. We do not always take this sufficiently into account; certainly not as regards mind. In our commerce with the world we forget how vast is the difference between the mental worlds of different individuals, so apt are we to judge others by ourselves. The natural mental diversity accounts, of course, for much of the difference, but over and above this, there can be no doubt that the general cast of the mind is enormously influenced by the surroundings. How different, for instance, are the mental worlds of the artisan, doctor, lawyer, divine! The fact is no doubt readily allowed in theory, but it is not practically acted up to. And thus when an argument is started, each looks at the matter from his own particular standpoint, and views it in a different light. If we could only rightly estimate the influence of E upon mind, there would be less of that terrible bigotry which so often warps the judgment, and makes an otherwise powerful intellect as ineffectual as a child's.

The animal organism is very pliant, very plastic. The process of moulding is termed education, and this is both conscious and unconscious, although the term is more commonly applied to the voluntary, conscious process. We may define the latter, or the "art of education," as the voluntary application of a specific E to plastic organic matter, with intent to improve its structure.* Plasticity is greatest in early life, and education is then most effectual. This process, be it remembered, includes not only mental moulding, but physical moulding likewise. Indeed, the two fall, in the long run, under the same head, for all mental training has a physical basis; wherefore mental training is physical training.

Now every structural change impressed upon an organism by its E, and other than that which is the *distinct outcome of*

* The structural change wrought by education is, of course, an evolutionary process. When a specific E, voluntarily applied, causes dissolution, as in a voluntary maiming of the body, the process would obviously not be one of education. Nor could surgical operations be classed under the head of "education." Nevertheless, they appear to me to be, in a sense, educatory, since the body is thereby altered for the better by the application of a specific environment in the shape of surgical skill.

heredity, is a natural variation—a natural variation from the *structural mean*. In other words, every acquisition is a natural variation. The difficulty here is to distinguish, in scientific language, between what is hereditary and what is acquired, for it is by no means easy to say whether a structural peculiarity is the distinct outcome of heredity, or whether it is not rather due to the application of some specific E; but even in the latter case heredity plays a most important part, since it is this, as will be more particularly shown later on, which determines the capacity of varying in a particular way.

Scientifically, it is perfectly justifiable to distinguish sharply between the hereditary and the acquired; practically, however, it is quite impossible. Scientifically, we may distinguish as follows:—If an individual is exposed to as negative an E as is compatible with life, it is evident that there will be little or no acquisition. We may, for purposes of argument, assume such a negative E—an E, namely, under which an individual will pass through a series of developmental changes, which are the outcome of the force of heredity, pure and simple—*i.e.*, altogether independent of external influences. It is, of course, impossible really to exclude altogether the influence of E, since life is due to the interaction of S and E. Assuming, however, such a theoretic standard negative E, both ante and post partem, we should then discover the individual to be that mean structural product whereof we have spoken. As a matter of fact, it would be utterly impossible to prevent acquisitions, for the organic textures are so plastic, so impressionable, that they are ever ready to be moulded by a multiplicity of diverse external agencies.

It is absolutely necessary to assume the theoretical existence of a hereditary product, pure and simple, in order to distinguish between that which is acquired and that which is inherited. Of course, we inherit *the power of acquiring*, but we do not *entirely* inherit the acquisition, for if we did not place ourselves under an E capable of effecting this structural change or acquisition, it would never appear, and such an E may in no way be necessary to life. Wherefore we are justified in

theoretically supposing an individual to pass through life without being exposed to such E, and we may speak of the individual such as he would then be, as the strict and sole product of heredity. What he is capable of becoming under particular environments belongs to the region of acquisition, and *every such acquisition is a natural variation.* There is no real difference between conscious education (or the conscious application of a specific E to plastic organic matter, in order to induce a specific variation or acquisition), and the more or less unconscious moulding of our bodies by the agencies around us —the semblance of difference lying in this: that the one is done consciously and for a purpose, while the other is not. And, again, between this latter kind of moulding and that moulding in nature whereby distinct and well-recognized variations arise, there is no distinction whatever. Both are due to E. In brief, the structural states which are not strictly inherited—*i.e.*, which would not appear under our theoretic negative E—are acquisitions, and all acquisitions are natural variations.*

It is therefore evident that the subtlest habit (supposing this to be *strictly* an *acquired* habit) is a natural variation, since fundamentally it is a structural variation wrought through a peculiarity of E. Indeed, pushing the matter yet further, we shall be compelled to admit that that part of our mental world, which is not strictly inherent, but acquired, falls under this same head of natural variation. We inherit in their fulness all the so-called instincts—our simple sensations and emotions—these would manifest themselves under the

* While it is correct to say that all acquisitions are natural variations, it is hardly true that all natural variations are acquisitions, or, in other words, that the latter are the sole cause of variations, and this for two reasons—(1) Because the union of unlike parents leads to a mean, unlike either, and this is a well-recognized cause of natural variations; nevertheless, it is only a secondary and minor cause, since it would be inoperative without the other. Acquisition is undoubtedly the primary cause, for if the world were peopled afresh from two individuals perfectly alike in all respects, save such as depend upon sex, the primary variation would be acquired. Unlikeness would thus appear, and this, in course of time, would tend to marked variations. Marriage of unlike individuals would still further increase the variation. (2) Reversions are natural variations. These, we have seen, are very largely due to E, but they are also due to the sexual union of unlike individuals.

most negative E compatible with existence; but all that part of the mental world which results from conscious education certainly belongs to the region of natural variation; for it has a structural equivalent which has been acquired, and an acquired structural peculiarity is a natural variation. We inherit, be it remembered, no knowledge, only the power of acquiring it. We inherit, in fact, an inconceivably plastic cortex, one ever ready, under specific forms of E, to take on natural variations. It is true that a considerable amount of knowledge could originate under the most negative E consistent with life; and this shows how largely the distinction between hereditary and acquired characters rests upon theory. Indeed, it is probable that many of our mental powers that are apparently acquired are in reality strictly inherent—the sheer outcome of heredity. For much of what is apparently acquired may be due, as Bastian observes,* to a post-partem evolution of the nervous system which is strictly developmental. The ganglia in the cervical region of the spinal cord are, as we had already occasion to observe, very imperfectly developed, and much of the subsequent development of them, whereby the individual becomes capable of executing complex movements, may be in a large measure purely developmental.

I have already said enough, I think, to make clear what I mean by the statement that the offspring of the same parents tend towards a certain mean, and that the deviations from this mean are due to differences of E. Such deviations, we have seen, are natural variations. Now, the theoretical mean is itself a natural variation, seeing that it differs from each parent, so that the unlikeness of the parents may be looked upon as one cause of natural variations. But if all individuals were to come into the world exactly alike, differences would be rapidly impressed upon them by the varying E, and it is this varying E which must be regarded as the primary cause of the variations. Having once got these differences, the marriage of unlike individuals must lead to still further variations, owing to the tendency towards the mean structural product of the two. *Hence we may regard differences in E*

* "Brain as an Organ of Mind": International Science Series.

as the primary cause of natural variations. Although I can see no escape from this conclusion, yet it is as well to note the fact that Darwin always wrote most guardedly concerning the causes of variability; and he evidently regarded it as quite impossible to explain variation on any general principle. The causes of variability are grouped by him under the following heads:*—

(*a*) Conditions of life.
(*b*) Habit.
(*c*) The use and disuse of parts.
(*d*) Correlation.
(*e*) Inheritance.

Now it seems to me that the causes of variations, as above grouped, all operate through peculiarity of E, and this is a convenient place to make good that assumption. Let us, therefore, consider briefly these several causes seriatim.

(*a*) *Conditions of Life.*—By this Darwin means the external forces to which the organism is exposed, such as food (this when taken into the body is a force derived from without), climate, &c. The nature of the food, both as regards quality and quantity, undoubtedly influences structure, and, inasmuch as different animals of the same species differ in regard to their food supply, they tend to vary. In such a case, of course, the external E—"food"—makes itself felt by modifying the internal E. Numerous examples of the influence of food and climate might be given.†

(*b*) *Habit.*—"Change of habits," says Darwin, "produces an inherited effect," as in the period of the flowering of plants when transported from one climate to another. This effect is obviously due to the altered E. The rhythm of the S is altered in response to an alteration in the rhythm of the E. The human organism may in similar fashion be educated to a different rhythm. A man may be taught to sleep by night or day, or at intervals of a few hours, and the organism may be so educated that defecation shall take place at equal intervals of time. There are many such rhythms, and they are of the utmost

* Crossing is an important cause of variations, but this is included under (*e*) Inheritance.

† "Animals and Plants under Domestication," vol. ii. p. 243 (second edit. revised).

interest. Now, in all cases in which the organism is educated to a rhythm, the effect is produced by a rhythm in the external E impressing a corresponding rhythm upon certain tissues.

(*c*) *Use and Disuse of Parts.*—The former, we know, causes hypertrophy of a part, the latter atrophy or dwindling of it. The result is due in both cases to an alteration of E. Let us instance the case of muscle. The E of each individual muscle-fibre is widely different when a muscle is constantly used to what it is when kept in constant disuse. This fact is so obvious to the physiologist that it is unnecessary to specify the difference in the two cases. Now, this modification in muscle-cell-E is in response to a modification in the ex-corporeal-E, and therefore the effect upon the muscle is indirectly brought about by the external-E of the individual. If an animal ceases to have need of a part, it is because the external conditions have altered.

The drooping of the ears in domesticated animals, for instance, is manifestly due to an alteration in their external conditions, and this latter is also the cause of the structural alterations in such cases as the following:—"In the domesticated duck,* the bones of the wing weigh less, and the bones of the leg more, in proportion to the whole skeleton, than do the same bones in the wild duck; and this change may be safely attributed to the domestic duck flying much less, and walking more, than its wild parents. The great and inherited development of the udders in cows and goats in countries where they are habitually milked, in comparison with the state of these organs in other countries, is probably another instance of the effect of use. Not one of our domestic animals can be named which has not in some countries drooping ears; and the view which has been suggested that the drooping is due to the disuse of the muscles of the ears from the animals being seldom much alarmed seems probable."

(*d*) *Correlation.*—According to this principle, alteration in one part is apt to go hand in hand with alteration in some other part or parts. Thus, white tom cats have blue eyes; hairless dogs, imperfect teeth; pigeons with short beaks have small feet, and

* "Origin of Species," p. 8, sixth edition.

those with long beaks, large feet. In all these cases, the parts sympathetically affected must, in some way, be anatomically and physiologically united, so that an E affecting one of them must necessarily affect the other, or others, at the same time. It may not be easy to trace this connection in all cases, but in some it is possible. The teeth, for instance, are dermal appendages, and anything interfering with the development of the skin will tend to affect the formation of the teeth. Wherefore the effects of "correlation" are wrought through modifications of internal cell-E, and the latter is ultimately dependent upon the external-E.

(c) *Inheritance.*—We have seen that the offspring cannot be like either parent, and hence one cause of variation. We also saw, however, good reasons for assuming that upon an ultimate analysis the variation is primarily due to E. "But," it is argued, "the principle of heredity is fickle." "No one can say . . . why the child often reverts in certain characters to its grandfather, or grandmother, or more remote ancestors; why a peculiarity is often transmitted from one sex to both sexes, or one sex alone." Now, reasons have already been given which favour the view that reversions are often brought about by peculiarities of E. Thus, a peculiarity of E may hinder development at a certain stage, and the individual may be born with some remote ancestral characteristics; and it is probable also that special likeness to one or other parent is chiefly connected with the E of germ and sperm during their birth and development. We saw that, if the parents are of unlike species, there is a tendency to reversion. But this is no real exception to the law of heredity, for the offspring is a mean structural product of the parents, leaving out of account all those characters which have been acquired since the period of ancestral divergence, and which refuse to blend in the offspring.

It is necessary now to observe that individuals differ vastly in the readiness with which they respond to different kinds of E. In other words, one organism will more readily take on new characters than another, or, in the usual language of the biologist, one organism will more readily "vary" in a particular direction than another. This diversity in respect of the

impressionability of an organism to a specific E manifestly depends upon inborn structure, and inborn structure depends upon heredity. Wherefore, the readiness with which an organism responds to a specific E depends upon heredity. In other words, *we inherit the power of acquiring.*

So vast is the part played by Structure in determining whether it shall vary or not, that Darwin maintained that peculiarity in variation depends more upon the Structure of an organism than upon the nature of its Environment.

CHAPTER XVII.

The Influence of Environment upon Structure (*continued*)—The Influence of the Post-partem Environment, considered from the Pathological Point of View.

I HAVE been at pains to consider somewhat in detail the influence of the post-partem E upon S. Though its influence over structure is insignificant as compared with that of heredity, which is the great determining power, it is nevertheless one which must be seriously taken into account, and it is utterly impossible to take a wide and philosophical view of the causation of disease unless we make a careful study of all those influences which are capable of affecting the body-structure. Pathology is a branch of biology, and must be studied on the lines of general biology. We have seen that disease is nothing more nor less than an improper inter-action of S and E, and our task has hitherto been confined to the elucidation of the question, "What are the causes of S?" for, in order to state in the most comprehensive terms the causation of disease, we could not be content with specifying the E which takes share in the morbid inter-action—we had also to state all we know as to the causation of the morbidly inter-acting S.

I have already observed that, from the pathological point of view, the post-partem E is the most important. Not that the ante-partem E is by any means powerless for evil. The nature of the mother's blood is capable of exerting an enormous effect for good or evil; and it is highly necessary to preserve the mother's nutrition during the months of gestation. Amongst the poorer classes, especially in large towns, the evils of bad E commence before birth; for the blood of most of their women is both impoverished and impure. Wherefore, if we wish to place an individual under a proper E from the earliest period of his existence, we must

not neglect the period of his uterine life, and we shall best secure the advantage of the child by placing the mother under a perfect E. To take a single instance, the development of the permanent teeth commences in the first months of embryonic life. If the mother's blood be deficient in certain elements, we can well understand how the germ of the future tooth will be improperly formed, and thus a tendency to early decay result. Unfortunately, the effect of bad teeth is not local: many secondary evil results may follow—neuralgia, indigestion, and consequent mal-nutrition—indeed, the effects may make themselves felt through the whole body.

In regard to our regulation of the post-partem E, let us ever bear in mind that it is potent in proportion as it acts early. I have more than once said that a small initial change may eventually lead to a very vast difference. Hear what Herbert Spencer says on this head:—

"In any series of dependent changes a small initial difference often works a marked difference in the results. The mode in which a particular breaker bursts upon the beach, may determine whether the seed of some foreign plant which it bears, is or is not, stranded, may cause the presence or absence of this plant from the flora of the land, and may so affect for millions of years, in countless ways, the living creatures throughout the land. . . . . The whole tenor of a life may be changed by a word of advice; or a glance may determine an action which alters thoughts, feelings, and deeds throughout a long series of years. . . . . A hair's-breadth difference in the direction of some soldier's musket at the battle of Arcola, by killing Napoleon, might have changed events throughout Europe."

Now, such being the case, we must, if we wish an individual to grow up healthily, most carefully regulate the E of his early extra-uterine life, for a slight neglect here may leave an effect which the greatest after-care cannot amend. But, unhappily, the young infant is but too often exposed to an injurious E. "The child cries, when it is born, because it feels, as Shakespeare says, 'that it has come on to the stage of fools.' It has its mouth stuffed with butter and sugar, its belly cramped, and its legs not allowed to kick. 'It has come on to the stage of fools.'" *

* H. G. Sutton.

It is probable that the entire future health of the individual differs according as he has been naturally or artificially fed. Some children, no doubt, do fairly well on the artificial method, but it is highly doubtful whether they would not do better still on the natural food. The following case is interesting in showing the different effects of the artificial and natural system of feeding. A woman brought to the hospital twin infants who were afflicted with congenital syphilis.* The ante-partem E of these twins was very similar, both in respect of the Normal and the Abnormal (namely, the syphilitic virus) ; one would therefore expect the two infants to be very similar in structure. And such is the case ; they bear the usual resemblance of twins, and are both afflicted with the same disease. Nevertheless, they show a considerable difference, and herein lies the great interest of the case. The great similarity of E for each twin ended at birth : the mother having only milk enough for one babe, the girl—for they were of different sex—was suckled, the boy being brought up by hand. The following note was copied from Dr. Abercrombie's note-book, whose patients the children were. "Both thrush badly for six weeks, with much rash about buttocks"—this from the mother. The note continues : "The boy has great bosses, most marked and characteristic cachexia, depressed nose, and a palpable spleen—rachitic. *The girl has no bosses, nor spleen, nose depressed. Is healthier than the boy, and can stand, whereas he cannot.*" This case shows most strikingly the influence of the early post-partem E upon the child.

We cannot, indeed, exaggerate this influence—it demands our closest attention. It is not too much to say that in civilized countries the vast bulk of the young of man are subject to an improper E. This is the case among the poor especially, and notably among the poor of large towns. The cruelty practised on infants year after year is a blot on our civilization—nay, it is

* It may be noted in passing that the so-called congenital syphilis is an acquired disease of ante-partem date—the fœtus having been exposed to a syphilogenic E. The so-called hereditary syphilis is probably no more hereditary than opium poisoning would be in an infant born of a woman under the influence of this drug. How it is that the mother so largely escapes in the ordinary cases of congenital syphilis I am at a loss to explain.

so serious that it almost tempts one to ask: Has such civilization any justification? The destruction of life among savages is, no doubt, greater than among civilized peoples, but death is at least prompt: whereas in civilized countries, tens of thousands of children are yearly tortured slowly to death, while as many grow up crippled for life. A number of children doubtless die of scarlatina, diphtheria, and so forth, through no fault of the parents—and here again death is more or less prompt; but the chief number die of improper feeding—of a disease popularly known as "consumption of the bowels." This is a sort of dysenteric diarrhœa, the main features of which are—large belly, slimy, bad-coloured, foul-smelling, and, sometimes, bloody motions. It is obviously an enteritis due to improper feeding. The unhealthy bowel is no longer able to properly act upon the food, which, therefore, decomposes, causing flatulent distension of the belly and foul-smelling motions. Such being the case, no wonder, then, that the child should get thin and die, or that, if it survive, it should grow up puny and delicate. At a time of life when every cell in the body is craving for food, the tissues are being both starved and poisoned: starved by the non-conversion of food into blood, poisoned by the absorption of abnormal intestinal products. I am inclined to think that this disease takes some share in the causation of both rickets and scrofula; but let this pass. Certain it is that it is a very common complaint; among the poor of London, *in a greater or less degree, it is universal.* I have scarcely ever failed to get a history of slime and foul-smelling motions in those children whose history I have thoroughly investigated; and that, not only in the case of children artificially fed, but in those brought up at the breast also, though to a much less extent. A history of slime and foul-smelling motions is a perfect test of the disorder. The mother should always be questioned concerning this latter symptom. Healthy motions have an unpleasant smell, but there is a wide gap between this unpleasantness and that due to the disease whereof I speak. If we have a history of foul-smelling motions extending over long periods of time, we have a distinct evidence of chronic intestinal disease; and chronic disease of this mucous tract, whose business it is

to change the food into the unformed part of the blood, necessarily leads to a universal modification of cell-E, which occurring at a period of active body-growth, produces an evil effect which no amount of subsequent care can entirely obliterate. How far this disorder is prevalent among the upper classes I cannot say, but I do know that it is fairly common among them. Wherefore, owing to this tendency to intestinal disease in children, the first question in almost every disease in children, should be, "What are the motions like?"

If we could keep the motions *always* normal, we should have few or no delicate children.

Now I have instanced this disorder, because it plays a fearful part in the destiny of man; exaggerated though this statement may appear, it is sober truth. Let it not be thought that those who survive its ravages are only temporarily affected. Their whole future is influenced thereby. If among a large family the majority are strong and vigorous, while two or three have been delicate from infancy, the chances are a hundred to one that a history of chronic intestinal trouble can be elicited as the cause of the delicacy.

And thus also it is with many other diseases; owing to the mutual dependence of the different tissues, it is impossible to localize a trouble: the effects ramify throughout the entire body. A neglected whooping-cough, a chronic tonsillitis, or what not, may stamp a life-long impress upon the body. How marked and extensive, for instance, are the secondary effects of prolonged tonsillar enlargement! The proper growth of the nostrils is interfered with, the mouth is kept continually open, indeed, the whole physiognomy is altered. Moreover, air is prevented from properly entering the lungs, and collapse is apt to take place; at all events, the lungs are imperfectly filled, and thus the normal development of the chest wall is interfered with. Now this interference with the proper growth of lung and thoracic wall will rapidly make itself felt throughout the entire organism. In the first place, the respiratory capacity being diminished, the entire bodily processes will sink, as it were, to a lower level, and the development and growth of the body will no longer proceed at their wonted rate; in the second

place, the altered shape of the bony framework of the chest will cause secondary modifications in other parts of the skeleton—in the curves of the spine, the inclination of the clavicles, the peculiar hanging of the scapulæ, and so forth. These are some of the results that may follow chronic enlargement of the tonsils in children; and such enlargement is itself the mere expression of a more general morbid condition.

This case is a good example of correlation, *i.e.*, of one or more parts specifically varying in correspondence with another part; and I have already said that the true explanation of correlation is to be sought in the influence of one tissue upon another, through a modification of internal cell-E. The so-called strumous condition, of which the enlarged tonsils are an outcome, results from imperfection of external-E. The child has been subjected to improper influences, and no doubt, in many cases, there is a hereditary "strumous" tendency through imperfection of ancestral E. Thus, we see that "correlation" ultimately depends upon modification of external E. But this by the way. My object in citing this case of enlarged tonsils is to show how a small local change is capable of causing a serious upset in the developmental processes of the body.

Similarly, how far-reaching may be the effects of a chronic constipation during the period of development, say, in a boy of six to ten years. In consequence of, it may be, a slight error in diet, he suffers from constipation. The mucous membrane of the rectum takes on catarrhal inflammation; threadworms soon infect the lower bowel, and cause an intolerable itching. The sexual system is sympathetically excited; there is priapism and a kindling of sexual desire; or the evil may result solely from a too long prepuce and the consequent accumulation of irritating smegma. Now the feelings control the thoughts. Unhealthy sexual thoughts will rage in the brain of this young child; soon the vice of masturbation is contracted, and practised, it may be, for years. Talk as we may, this must interfere with proper development. I am convinced it interferes with proper cerebral evolution, and that indirectly the entire individual is thereby altered.

See, then, what a simple constipation may bring about: it may produce effects which shall be felt throughout the body even to the end of life. And this constipation and unhealthy state of mucous membrane may result from an error in diet, in other words, from an imperfection in external-E; and thus an apparently slight imperfection in E is capable of moulding the S into a distinctive shape, and no power of ours can subsequently put it right—cast it into its true natural mould.

It is an interesting task to endeavour to trace the influence of the external E upon the post-partem developmental processes in some particular case. Biographers have analysed in the most painstaking way the influence of mental surroundings upon the minds of many great men, but very little has been written as to the influence of the physical E upon the physical man. The best minds, like the best bodies, have undoubtedly grown up under a favourable physical environment. Occasionally we see a strong brain in a weak body, but in such cases the cerebral result would, I think, certainly have been better if circumstances had permitted the free growth of the body. Pope would have been a greater man if his body had grown to greater perfection. It is sometimes argued that, because a particular man drinks inordinately for many years, and nevertheless lives to a good old age, therefore alcohol does no harm; the real fact being, however, that he lives on in spite of the alcohol, and that without it he would have lived yet longer. And so it is with the strong brain and the weak body; the mind is great in spite of the deteriorating influences of unhealthy surroundings, which must necessarily tell injuriously upon the entire body structure, whether of the brain or any other tissue. The mental capacity would have been greater under more favourable external surroundings. Mark, I say, the *capacity*—that is, the potential power. Often the weakness of body develops a reflective turn of mind, by rendering an individual dead to many alluring distractions which draw the minds of others outwards. The sickly individual thus mentally thrust in upon himself, will develop to the full faculties which would otherwise have remained latent.

Be this as it may, there can be no doubt that many physical peculiarities of individuals may be accounted for by a careful study of the physical E of their youth. See what a hard life Dickens had! The greater part of his early years was spent in the impure air of central London. London air is bad enough under the most favourable circumstances, and it was probably very bad in the rooms where much of Dickens's youth was spent. Then there can be little doubt that he was starved as a boy for many years. Subsequently to this unhealthy bringing up, he led a life of altogether excessive mental toil and excitement, and the end was just what we might have expected. "But," it will be argued, "his mental success was great." It was indeed. Yet there have been greater men than Dickens, and Dickens had probably been a greater man under more favourable physical circumstances. He had, of course, the advantage of mental surroundings favourable to the development of his *capacity*, such as it was; but I contend that, under more favourable physical surroundings, and with equally favourable mental surroundings, that capacity would have been greater.

Such being the potency for evil of an early mal-E, we must, I repeat, most religiously see to it that our children are placed under a proper E, and our care should be great in proportion to the youth of the child. A serious affection in a child *must influence all the developmental processes* occurring after it. A similar disease in a full-grown man is infinitely less damaging, for in him development has come to a standstill.*

For this reason, too, we should be prompt in our efforts to cut short every malady, no matter how slight, occurring before the period of complete maturity; for, while the malady is present, there must be an interference with proper development, and, if that interference lasts long, the individual will lose ground which he cannot afterwards recover. Take a case of chlorosis. One might be inclined to argue: so long as we ultimately cure the complaint, it does not matter whether we

* Minor processes of evolution may continue till a very late period in life, and this is more particularly true as regards the nervous system; nevertheless, the statement that development has come to a standstill in a full-grown man is to all intents and purposes accurate.

do so now or a few months' hence, except for the temporary inconvenience of the patient. Never was error more fatal, for, apart altogether from the fact that chlorosis may immediately predispose to other ills, such as gastric ulcer, and possibly phthisis and heart disease, it stands to reason that rapidly developing tissues must suffer considerably if they are bathed for months together in thin watery blood. On no tissue will this evil effect be greater than the nervous. I have seen cases of chlorosis in quite young girls lasting over a year. Surely this must lead to a permanent crippling of the young and rapidly growing ganglion-cells!

CHAPTER XVIII.

The Morbid Inter-action of Structure and Environment—All Disease Processes probably attended by Structural Change, and therefore Natural Variations—Structural Deficiency.

HAVING inquired into the causation of S and E separately, it now becomes necessary to consider these two vital factors in the mutual inter-action of disease, for we have seen that disease is an abnormal inter-action of S and E. It will be remembered that we first inquired into the nature of E, and that the last chapters were devoted to the consideration of the causation of S. We found that S was mainly the outcome of heredity, but that it was also influenced, though in a lesser degree, by E. Accordingly we treated of the causation of S under two heads: Under the one we considered the general principle of heredity; and under the other the influence of E upon S. So that E has had to be treated of in a twofold manner—(1) As one of the two great vital factors; (2) As a plastic agent.

We now cease to study the two great factors of disease apart, and proceed to consider their morbid inter-action—namely, disease.

One of the first things that strikes us regarding the power of E to set up disease is, that it varies widely with the *nature of S.* This is, of course, as we should expect; for, while speaking of the simple cell, we saw how S + E represents certain material conditions, and how, as a result of such conditions, a definite inter-action takes place. Now, differences of S signify differences of these material conditions, and, in consequence, differences in the result. S may be such that S + a particular E shall call forth healthful inter-action, or such that S + this *same* E shall issue in morbid inter-action.

This truth is abundantly exemplified in the diseases of man.

One often sees, *e.g.*, two individuals—we will call them A. and B.—exposed to an exactly similar E. A. contracts disease, while B. escapes unhurt. In such a case, we say A. has a greater proclivity or predisposition to the disease. The two cases stand thus—

(A.) S + E = Disease. (B.) S + E = Health.

Since the result differs, it follows from the law of causation that the material conditions must be different, and, the E being the same in both cases, the S of A. must differ from that of B. Hence the power of the same E to call forth a given result differs in the two cases. This E is, perhaps, as powerless to produce disease in the case of B. as is a spark to explode damp gunpowder. In short, the nature of S determines whether it shall or shall not take a morbid action.

There is no more conclusive way of proving how differently different individuals respond to the same E, than by studying the actions of drugs upon different individuals, since, in this case, we can regulate the specific E most accurately, and be quite certain, moreover, that we are exposing different individuals to exactly the same.

So differently, indeed, do different individuals respond to the same dose of the same drug, that we have thus a ready means of testing and proving individual differences of structure, which are quite undiscoverable by microscopic or other modes of examination; just as, in fact (I am using Darwin's simile), we can discover chemical differences in different fluids by the different ways in which they respond to different re-agents.*

The nature of the S determines, therefore, whether a particular E shall or shall not throw it into morbid action.

* By means of drugs we are able to subject a number of different individuals to *exactly the same specific E*, and with what diversity of results everybody knows. These differences in S are termed idiosyncrasies. In this connection, Darwin makes the following remarks: "There appears to me a strong analogy between the same infection or contagion producing the same result, or one closely similar in two distinct animals, and the testing of two distinct fluids by the same chemical re-agent" ("Descent of Man," p. 7). And, just as we infer similarity or difference between two fluids by the similarity or difference in their behaviour towards certain re-agents, so likewise can we infer similarity or difference among different living organisms, for it is, as above remarked, the nature of S which determines whether it shall or shall not take on a particular action, when exposed to a particular E.

That the manner in which S responds to E depends in large measure upon the nature of the S is a fact familiar to the biologist. Darwin is very careful to insist upon the important part played by S in determining whether an animal or plant shall vary under a particular E.* He maintains, indeed, that the occurrence of the variation depends more upon the organism (=S) than upon the E.

It is easy to show that the "nature of the organism" (=S) has much to do with its tendency to variability, for of many organisms subjected to practically the same conditions, some will vary, and others will not, and this difference in response to E must depend upon differences in S. Gardeners have often great difficulty in getting plants to vary in a particular direction, and much care is directed towards this end.

The term "variation" is generally applied solely to such structural changes as are obvious to the senses, but it should be remembered that the physiological response to a specific E need not display itself in a discoverable structural change. This is sufficiently proved by the fact that many plants do not obviously vary until after they have been exposed to a specific E for several successive generations. There can, however, be no doubt that all this time a steady structural change has been taking place. Indeed, the subtlest and most infinitesimal force falling upon a living organism causes a modification of its structure. Hence, when the E appears to cause a simple functional change only, without any corresponding structural alteration, we may, nevertheless, regard the organism (for the time being, at least) as a natural variation, for there can be little doubt that it does undergo a temporary structural change. I say, a *temporary* structural change, for, unless the specific E be persistent, the structural change may only be temporary. It need hardly be said that organisms differ quite as much in respect of this "functional reaction," as we may conveniently term it, as they do in regard to the more obvious structural response. Indeed, the latter is but the prolonged result of the former.

The same remarks apply to pathological variations. In a

* "Animals and Plants under Domestication," vol. ii. pp. 275–282 (second edit. revised).

later chapter we shall discuss the question whether structural alteration is a necessary concomitant of disease. The above observations prepare us for the conclusion that some structural change is a constant accompaniment of morbid processes. It is quite obvious that a very large number of disorders are attended by distinct structural changes—*e.g.*, pneumonia, and cirrhosis of the liver. All such diseases constitute distinct natural variations. But even when the E causing the disease produces what seems to be only functional change, there must, according to the arguments just used when speaking of physiological functions, be some structural alteration.

All natural variations, whether physiological or pathological, are, therefore, in the last resort, the same—viz., alterations in structure, wrought by the peculiar action of E. If the action of the E does not tend to break the harmony between the S and the external-E, the variation may be spoken of as physiological; if, however, it tends to upset, in a very marked degree, what Spencer would term "the equilibrium between the inner and outer forces," it may be spoken of as pathological. The two classes, in fact, pathological and physiological, run into one another, and it is by no means an easy matter—as we shall see in another place—to define an ideally normal S.

Some, however, will be inclined to say that the distinction between pathological and physiological variations is very great, their criterion being this: that all pathological variations are dissolutionary.* There are objections to this view; but even supposing that physiological and pathological variations are thus sharply separated from one another, the two none the less fall under the great class of natural variations. And my object in the foregoing remarks has been to emphasize this fact—namely, that pathology, being a branch of biology, has to be studied on the same general lines. It is, at all events, convenient to regard all morbid processes as natural variations (temporary or permanent); but if some contend that diseased processes need not be accompanied by

* I am here speaking of actual pathological variations—*i.e.*, of actual disease. For the distinction between actual and sub-pathological variations, *vide* p. 38.

structural alteration, and are not, therefore, natural variations, it matters not; both pathological and physiological changes can yet be brought under the same general principles. I shall, therefore, in this chapter, regard all cases of disease as pathological variations. I do not think I shall greatly err in so doing.

Diseases, then, belonging, as they do, to the great class of natural variations, will obviously be governed by the same laws as to causation. Just as, in response to specific E's, some organisms will readily take on certain physiological variations, so some organisms will readily take on certain pathological variations. And just as, on the other hand, some organisms refuse to take on certain physiological characters, so some equally refuse to take on certain pathological characters.

We can no more compel an animal or a plant to vary in any given pathological direction, by subjecting it to different forms of pathogenic E, than we can force on animal or plant any particular physiological variation by exposing it to specific modifications of E. And we shall have no difficulty in believing this, if we keep ever before us the kinship between pathological and physiological variations.

No doubt we can fracture a skull or inoculate a poison, but who will engage to produce general paralysis of the insane in any given individual (to make no mention of other more subtle forms of mental disease) by applying to him a specific pathogenic E? Where, again, is the experimentalist that can produce at will such diseases as bulbar paralysis, ophthalmoplegia interna, primary lateral sclerosis, goître, hæmorrhage into the internal capsule, mediastinal tumour? Even disorders whose causation is more or less perfectly understood, such as drunkard's liver and granular kidney, do not always occur under the E which is wont to produce them.

"I do not believe," says Sir J. Paget,* "that through any external conditions whatever, and independent of inheritance, any one can become the subject of cancer, gout, tuberculosis, or any disease allied to them. External conditions may hasten the appearance of such diseases, determine their seat, and

* "Clinical Lectures," p. 414.

variously modify them in the person affected, but seem to me utterly inadequate to originate them."

Although more recent evidence tends to negative this conclusion (for gout may perhaps be induced independently of heredity—more especially if the individual come under the influence of lead in addition to other gout-producing agents—and tuberculosis has been inoculated in a large number of animals), nevertheless, this conclusion emphasizes Paget's belief, which is surely correct, that the special tendency to the disorders in question is gradually evolved, and that without such tendency, such peculiarity of S, they are never met with under any ordinary circumstances.

The same line of argument might be pursued in respect of all sorts of disease. Can we even guarantee to infect every child with a given specific fever? Are there not some children, who, although they continually consort with others suffering from a specific febrile disorder—nay, who, although they be even inoculated with the virus thereof, will yet remain untouched by the disease? This inability of the S to be morbidly affected by a specific virus is well shown in the case of individuals who have already been thus morbidly affected. Such, we know, are generally protected against future attacks of the disease, but some are from the beginning proof against the poison; and in this connection it is interesting to remember that some races are proof against specific E's, which to others are highly injurious.

Instance the ague poison. And this disparity of different individuals in the matter of responding morbidly or otherwise to parasitic organisms, does not apply to the microscopic parasites only; it is a curious fact that different races of men differ in their liabillty to be attacked by the several macroscopic parasites. "The surgeon of a whaling ship in the Pacific assured me that when the pediculi, with which some Sandwich Islanders on board swarmed, strayed on to the bodies of some English sailors, they died in the course of three to four days."* Humboldt remarks: "White men, born in the torrid zone, walk barefoot with impunity in the same

* "Variation under Domestication," vol. ii. p. 265.

apartment where a European, recently landed, is exposed to the attacks of pulex penetrans."* There is no occasion to pursue this subject further, for it is known to all that certain individuals refuse to respond morbidly to E's which are capable of setting up distinct morbid action in others.

But among such as *do* respond there is vast difference in respect of the readiness of response to any particular pathogenic E. This "readiness of response" signifies the inherent tendency to particular diseases, and may be spoken of as *structural deficiency*. Many persons would quarrel with this term, since of two individuals, one of whom, we will suppose, is proof against the attack of the common flea, while the other is exceedingly liable to be bitten by it, they would be unwilling to attribute to the latter a structural deficiency, although, no doubt, they would allow the term in the case of an individual who responded readily to a gouty or tubercular E; but we shall see, in another place, that normality and abnormality of structure are relative terms, and can only be considered in relation to E. If $S + E$ be such that healthful inter-action results, then both may be regarded as normal, but if $S +$ this same $E =$ disease, then S is abnormal in regard to that E, and, therefore, the term structural deficiency, used in this relative sense, is justifiable.

We may have any degree of structural deficiency, or tendency to particular disease. In the case of such diseases as gout, tubercle, or cancer, we may, perhaps, speak of this deficiency as an actual "*disease taint*," but in many cases of structural deficiency there is obviously no condition of tissue meriting this designation, as when an individual is structurally deficient as regards certain skin parasites. In thus speaking of the intensity of disease proclivity, I wish to denote the quantity of pathogenic E necessary to call forth the actual disease—the less the structural deficiency, the larger the quantity of pathogenesis needful to call forth the actual disease, and *vice versâ*. Wherefore we arrive at this principle: *the quantity of mal-E needful to call forth disease is in inverse ratio to the structural deficiency.*

* Quoted by Darwin, "Variation under Domestication," vol. ii. p. 265.

CHAPTER XIX.

The Symbolical Method of Expressing the Relative Share taken by Structure and Environment in Causation.

WE shall do well, if we can, to assign to S and E respectively their relative share in the production of any given case of disease—to say what is the extent of the structural deficiency, and what the intensity of the mal-E.

Since disease depends upon an inter-action of S and E, it is obviously impossible to eliminate E from causation, even though the disease burst out spontaneously under the most favourable E. But if the inherent tendency to disease in any individual be so strong that the disease must needs break out, no matter how favourable the E, we may, for all practical purposes, eliminate the share of E in its causation. In such a case the individual may be said to contain within himself the full potentiality of the disorder.

In considering the degree of structural deficiency, or proclivity to some particular disease, we shall discover two extremes. At one extreme end we have the class of cases whereof mention was just now made—namely, in which the proclivity to a particular disease is so great that it must needs break forth under the most favourable Environment; and at the other extreme, a condition of S which refuses altogether to be thrown into morbid action under the most intense pathogenic E possible. These remarks do not, of course, apply to all pathogenic E's, for there are many mal-E's which excite disease in all alike—*e.g.*, prussic acid, or the continued breathing of foul air. Be it noted, moreover, that, by structural deficiency, or proclivity to disease, I wish to denote *proclivity towards some special disease.* While a vast number of specific E's will produce disease in all mankind, each one does not always produce the same disease. Prussic acid, *e.g.*,

will produce practically the same morbid action in all, but this is not true of a foul atmosphere, which will tend to induce several distinct disorders, according to several distinct structural proclivities, or, as I have called them, *deficiencies*.

Between the above two extremes of absolute impunity from a particular disease, and absolute inability to escape therefrom, there is a long series of fine gradations. An individual may, in fact, have any shade of structural deficiency, or tendency towards a particular disease, from absolute security to impossible escape. This fact may be well illustrated in the case of insanity. Some there are who will not lose the even balance of the mind under the most dire provocation. Let them be subjected to the rudest mental shocks, the sharpest pangs of grief, the insidious torment of worry, the wear and tear of excessive intellectual toil, or any mental agitation whatsoever—the mind still pursues the even tenor of its way. But there are others in whom the slightest disturbance is sufficient to upset the mental balance, who will become insane even though every possible care be taken to guard them from exciting influences; and between these extremes we can fill up a long series of fine gradations needing an ever-increasing quantity of specific pathogenesis to call forth the disorder. By a specific pathogenesis I mean such E as tends to call forth a particular disorder, and it is impossible to enumerate all the various forms of E which would tend to excite into actual being an insane proclivity.

Now, can we in any way symbolize the relative share taken by S and E in the causation of disease? Let us suppose a given disease to be made up of eleven units, and let the share in causation taken by S and E respectively be represented by any number from one to ten: it would be manifestly incorrect to assign the full number (eleven) to either, seeing that neither S nor E alone can constitute disease. Then, inasmuch as $S+E =$ the disease, we may arrange the following table:—

(An individual in whom the disease bursts out spontaneously).	*a*	$S_{10} + E_1 = 11$
	b	$S_9 + E_2 = 11$
	c	$S_8 + E_3 = 11$
	d	$S_7 + E_4 = 11$
	e	$S_6 + E_5 = 11$

	f	$S_5 + E_6 = 11$
	g	$S_4 + E_7 = 11$
	h	$S_3 + E_8 = 11$
	i	$S_2 + E_9 = 11$
	j	$S_1 + E_{10} = 11$
(An individual in whom the largest quantity of specific pathogenesis is unable to induce the disease.)	*k*	$S_0 + E_{10} = 10$

In the first case (*a*), the inherent tendency is represented by ten and the E by one. In such a case the disease breaks out spontaneously, *i.e.*, is fully inherent, for it occurs under the most favourable E possible. It is necessary to represent this by the number one, because we can never entirely eliminate the E, seeing that disease is an inter-action of S and E. In the last case (*k*), the largest quantity (ten) of specific pathogenesis, that is, the most intense disease-producing E, is unable to excite the disease; the S totally refuses to respond morbidly in the specific way, and the inherent tendency may therefore be represented by 0.

Let us apply this numerical method to illustrate the share in causation taken by S and E respectively in a particular disease—*e.g.*, *insanity*. "It must be borne in mind," says Maudsley, speaking of the causation of insanity,* "that hereditary predisposition may be of every degree of intensity, so as, on the one hand, to conspire with certain more or less powerful exciting causes, or, on the other hand, to suffice of itself to give rise to insanity, even amidst the most favourable external circumstances." Let us endeavour to give numerical expression to these words of Maudsley. The formula $S_{10}+E_1$ signifies that, under the most favourable E, the individual will become insane; S_9+E_1, that, with the greatest conceivable care, the disorder may be averted. In the latter case it would be necessary to protect the individual from a long array of influences; for there are many diverse circumstances included under the specific pathogenesis of insanity, such as mental excitement or shocks, child-bearing, fevers, and indeed anything and everything which tends to reduce the bodily nutrition, be it bad air, improper or deficient food, lack of exercise, or what not. It would, indeed, be impossible to

* "A System of Medicine," edited by J. Russell Reynolds, M.D., &c., p. 13.

enumerate all the causes which would directly or indirectly tend to ignite the very ample supply of neurotic dynamite, and which would, therefore, have to be included under the specific pathogenesis.

It would, of course, be possible for the disease to be called forth by a more powerful exciting cause—*e.g.*, E_5; but in such a case the excess of E (three) is in a manner inoperative. For, speaking, as we are, of the pathogenesis of insanity without any regard to the intensity of the morbid action, we cannot get more than 11, since this number represents the full disease. No doubt a greater quantity of specific mal-E—*e.g.*, prolonged mal-hygiene—might induce a more intense attack of the disease, and we might represent this by $S_9 + E_{10} = 19$, but I am not attempting to represent numerically the *intensity* of the disease; I am dealing only with the actual presence or absence thereof, the number 11, or any higher number, denoting the presence of insanity, the numbers below this its absence. It would, perhaps, be possible, however, to somewhat roughly denote in this numerical way the intensity—the *dose*, if we may so put it—of the malady. Thus the most hopeless case of insanity might be represented thus: $S_{10} + E_{10}$. Here we have nine units in excess of the minimum quantity of genesis, and this formula would signify that an individual in whom the tendency to insanity was very rife had been subjected to the largest possible quantity of insanity-producing E. Let it be noted that a specific pathogenesis dates from the earliest period of life. It is well known, *e.g.*, that many neuroses attend rickets, and this may be the starting-point of very serious nervous disorders in after-life.

To return to the symbols: $S_{5\cdot5} + E_{5\cdot5}$ would indicate that each vital factor takes an equal share in causation; $S_1 + E_{10}$, that an exposure to the largest possible quantity of specific mal-E is needed to call out the disease; while $S_0 + E_{10}$ implies that the individual refuses to become insane, even though he be rigorously subjected to every possible insanity-producing cause. Some may think no such individual exists. It might be argued, for instance, that insanity can always be induced by traumatic causes. It is, however, only exceptionally that such a result follows upon a head injury. By voluntarily disor-

ganizing the brain (and this is out of the sphere of practical causation) we might, no doubt, render any given individual insane; but who would engage to induce in this or any other way the many different kinds of insanity from which man suffers? For the diseases of mind are many and subtle, and we may lay it down as a fact that individuals exist in whom it would be impossible to induce any given variety of insanity.

The following instance of the same disease affecting twins is interesting, inasmuch as the relative shares taken by S and E in causation were probably exactly the same for each individual. "Dr. Gregory's twin children . . . . were both seized with croup on the same night, having been walking together in the sunshine during the evening in a cold wind."* There was doubtless some structural peculiarity in these children, which rendered them particularly prone to croup, for it is probable that few others would have contracted the complaint under like external circumstances. A similar instance is the following: "I once saw . . . . twin boys, eight months old, in each of whom a small abrasion formed in the raphe of the perinæum, and became covered with membrane. This membrane extended, though unaccompanied by any other local symptoms of diphtheria, to the margin of the anus, and to just within the internal sphincter. Both children died within a week from the commencement of the illness, sickening, as under some grave constitutional disease, with troublesome diarrhœa and exhaustion, which stimulants failed to remove. The identity of this disease with ordinary diphtheria is established beyond doubt."

* Hilton Fagge, "Practice of Medicine," vol. i. p. 79, quoting Sir T. Watson.

CHAPTER XX.

Some Further Applications of the Symbolical Method.

It has been observed that a particular mal-environment may extend over many years: it may, in fact, date from the very first moments of life. Now it is obvious that, if the E has been in operation during a long time, rendering the individual from day to day more and more prone to the disease, a gradual change in S must have been taking place all this time; a specific "deficiency" may thus go on increasing, until finally the disease is capable of being set up by a numerically small E, and thus, at the time of the actual occurrence, the causation might be represented by such a formula as the following: $S_9 + E_2 = 11$.

In the foregoing table, however, the S is supposed to represent that part of the individual which is the pure and simple outcome of heredity as distinguished from those structural peculiarities which have been wrought through E, while E symbolizes the entire specific mal-environment from the period of birth. It would be more accurate to start from the earliest period of uterine life, for we have seen that the intra-uterine E plays a very important part in shaping the destiny of the individual, but it is sufficient for our purpose to take the period of birth as our starting-point. At this time the tendency to a particular disease might be S_1; during a number of years' exposure to a specific mal-E this might change to S_{10}. In such a case the causation would be best symbolized: $S_{1+9} + E_1 = 11$.

If we wish to ascertain the entire share which E has taken in causation, it is in fact necessary, in the case of very many diseases, to extend our survey over the whole previous life. Thus, in discussing the causation of insanity, Maudsley says: "What should ever be borne in mind is, that *all the conditions*" (italics are mine: by "all the conditions" the author is here referring to conditions of structure as well as of E) "which

conspire to the production of an effect are alike causes, alike agents, and that there is, in most cases of insanity" (I should have preferred to say "all cases"), "a concurrence of conditions, not one single effective cause. Mental alienation often appears as the natural issue of all precedent conditions of life, mental and bodily, the outcome of the individual character as affected by circumstances; in such case, the germs of the disease may have been latent in the foundation of the character, and the final outbreak is but the explosion of a long train of antecedent preparation. In vain, then, is it to try to fix accurately upon a single cause, moral or physical."

In the above symbolical formulæ, E has always referred to the external environment; but in certain cases of disease this letter may conveniently symbolize the share taken by local bodily change in provoking disordered action in another part of the body. We have seen that diseases rarely remain strictly localized; that, owing to the mutual dependence of tissue upon tissue, disease in one part is very apt to set up morbid action in others. Now, it often happens that the most obtrusive, and, indeed, the most important, morbid action is not the primary one, but some morbid action secondary to it. Thus, the local trouble of indigestion, or the irritation of a worm in the bowel, may excite an epileptic fit; thus also, gastric disturbance or bronchitis may bring on an asthmatic paroxysm; and, in like manner, a decayed tooth may cause neuralgia.

In considering the causation of disorders thus arising, we may, then, conveniently regard the central erring tissue as an independent S, and the peripheral irritation as an E acting thereon, and in all such cases we may lay down the general principle that the amount of peripheral irritation needful to call forth the abnormal central state is in inverse proportion to the abnormal tendency of the centre. The latter may, as it were, be so fully charged with dynamite, that it will explode spontaneously: as when an asthmatic or epileptic fit occurs though every care be taken to prevent any peripheral irritation. On the other hand, the morbid tendency may be so slight that a very intense peripheral irritation is requisite to bring out the morbid action. In such a case the causation may be numerically expressed thus:

$S_1 + E_{10} = 11$; and when the fit is excited by the barest peripheral irritation, we may symbolically express the fact thus: $S_9 + E_2 = 11$.

And it is worthy of note that in such cases as the above we may cure the disease by reducing the number of units whether of S or of E. An individual is suffering, let us say, from neuralgia of the fifth nerve. He is anæmic and haggard-looking, and on inquiry we find that he has been over-worked and worried. Examination of the teeth discloses on the side of the pain a decayed molar, which is tender to the touch. Now, it may happen that the neuralgia disappears after withdrawal of the offending tooth, in which case the causation may have been somewhat as follows: $S_6 + E_5 = 11$. By removing the five units of causation, we cure the disease. On the other hand, the neuralgia may continue unabated after the tooth has been drawn, when the causation would be thus represented: $S_{11} + E_0 = 11$. Such a case, however, may not infrequently be cured by diminishing the pathogenic value of S. Supposing, for instance, the causation to be more or less accurately represented by the formula $S_6 + E_5$, it will follow that, if by tonics and rest we can reduce the S_6 to S_1, the patient will be cured.

We are, indeed, often called upon to fix the pathogenic value of E and S respectively in cases like the above, for our treatment may depend upon the conclusion we arrive at. Some physicians, for instance, value E (note, that I am not now talking of the external E) at a very low figure in such disorders as epilepsy and neuralgia—practically ignoring it, in fact; while others assume the chief or a large share of causation to reside within it.*

I have given these few instances, and might add many more, with a view to show how much the numerical expression of our thoughts would tend to give them a precision which they otherwise lack.

A structural deficiency, or disease proclivity, may be tem-

* It is evident, from a perusal of Dr. Gowers' work upon Epilepsy, that he does not attach much importance to the part played by "peripheral irritation" in the causation of this disorder; and it may be said that the great purpose of Dr. Anstie's treatise on Neuralgia was to show that the essential cause of this complaint lay in the sensory centres.

porary or permanent. It is well known that an individual will sometimes escape unhurt when exposed to a given mal-E, while on other occasions this same E will cause disease. These differences are due to temporary modifications of S. At one time an individual may be S_1 as regards a given mal-E, at another S_{1+5}, so that E_5, which, in the one instance, is powerless to harm him, will, in the other, cause disease, owing to temporary structural alteration. But, in such cases as these, the effective mal-E, although apparently the same, is not actually so; for the temporary alteration in S must itself be due to temporary peculiarity of E, and this latter may be unwittingly excluded from the sphere of causation; yet, if it predisposes to the disease, it ought obviously to be included under the specific pathogenic E. A child, for instance, is on two separate occasions equally exposed to the scarlatina E. The first time it escapes unhurt, but on the second occasion contracts the disorder. There must, therefore, be some difference in S on the two occasions. On examination it is perhaps discovered that in the one instance the child was exposed to the influence of the poison on a full stomach, but that on the second occasion it had been without food for some time. Now it is obvious that this want of food ought to be included with the specific virus as part of the pathogenic E, since in this case the two together were necessary to produce the disease. To give a further illustration of this point. Troops under privation and exhaustion are more liable to suffer from dysentery than others, and, therefore, the privation and exhausting influences, as well as the virus, must be included under the effective mal-E. Nevertheless in such cases we probably have actually to do with temporary structural alterations induced by E.

It may be asked what place in the above list external violence ought to occupy as a mal-environment? Traumatism is so potent to produce disease that we shall perhaps be inclined to give it a high numerical value. The fact is, however, that the numerical value of S is equally high, for the S is very susceptible to external violence, and this susceptibility varies with the individual. A twist that would snap the limb of an infant would have no effect upon that of an adult; a bullet that would flatten impotently against the side of a hippopotamus would destroy most other animals. But there is no occasion whatever

to use this symbolical method in the case of injuries, and, therefore, I will not attempt to show how it could be rendered accurate. I am, indeed, not ambitious enough to hope to reduce to scientific precision this method of valuing the relative shares taken by S and E in the causation of particular diseases. It is obviously impossible to do so. I have used it simply as an instrument of thought, and it may perhaps be occasionally useful in studying the causation of a particular disease, by presenting the actual state of things to the mind in a more or less tangible form.

In the light of our present position, let us examine the following statement made by Dr. Russell Reynolds in the introduction to his "System of Medicine."

In speaking of "predisposing causes" of disease, he reminds us that heredity, sex, age, constitutional peculiarity, congenital or acquired, are generally included among them. We have seen what a potent part heredity takes in determining S, and that *age* and *sex* necessarily fall under the same principle. Moreover, it is obvious, from former remarks, that "constitutional peculiarity," which is nothing else than structural peculiarity, is either hereditary or acquired (=due to E). According to our manner of viewing it, it must be one or the other, for we have seen that no peculiarity can arise spontaneously; if not due to heredity, it must be due to E, a *congenital* peculiarity being either hereditary or the result of peculiar ante-partem E.

Now to proceed to Dr. Reynolds' statement: "In regard to heredity-taint and constitutional peculiarity, we must admit *that they are in reality diseases*" (my own italics). Later on he affirms them to be part of the disease itself. Thus, a "man of tuberculous family, and with latent tubercle, was yesterday apparently well, but he was exposed to cold, and to-day he has tubercular pneumonia. This constitutional state predisposed him to the evil which the exposure excited into activity. *It was not a cause of the disease that was there, but an integral part of the affection.*"

We have already seen that we cannot separate S from causation, seeing that disease is a peculiar inter-action of S and E. But, whether we are justified in calling any pecu-

liarity of S which renders it apt to be thrown into morbid action by a specific E, an integral part of the affection, is an open question, for such a proceeding rather suggests that disease is a one-sided process, in which S alone takes part —that the individual actually contains within himself the slumbering entity. There is no objection whatever to our thus regarding disease, provided we bear the fact clearly in mind that disease is a two-sided process, but we must then be prepared to admit that every man contains within himself an integral part of every disease to which his flesh is heir, be it tubercle, measles, fractured skull, flea-bite, or what not: that is to say, each of us contains an integral part of fractured skull, for instance, seeing that we alike suffer therefrom if we do but expose ourselves to the necessary E. Most of us, too, contain an integral part of the specific fevers, for do we not respond to the noxious action of the several parasites which cause these diseases? and there are few who do not contain an integral part of "flea-bite." Indeed, it is not necessary to individualize the diseases which on this view slumber potentially before we actually suffer from them, seeing that they comprise, as just now stated, every disease which it is possible for man to contract.

When the tendency to a particular disease is very strong—S_8 for example, or S_{10} (in which case it bursts out spontaneously)—there is certainly a great inclination to regard the individual as containing within himself a part of the disease before he actually suffers from it, but we cannot sharply divide individuals into the predisposed and the non-predisposed—into the tubercular and the non-tubercular, for example—for we meet with every shade of predisposition, from complete immunity, in some diseases at all events ($=S_0$) to impossible escape (S_{10}). Probably, no individual is absolutely impregnable to tubercle. Hilton Fagge is very explicit on this point. "Probably," he says, "there is no family in which the consumptive tendency is so strong that it could not be kept in abeyance by hygienic precautions if they were thoroughly and vigorously carried out; and, on the other hand, there are very few families (if any) in which the disease may not show itself in such members of it as systematically neglect their health, or are exposed year after year to unfavourable circumstances."

CHAPTER XXI.

Recapitulation.

I NOW propose to summarize some of the more important conclusions arrived at in the preceding chapters.

The various phenomena of nature are found to be definite and regular in their sequences, the same results always following upon the same conditions. Such being the case, we speak of the conditions upon which a particular event always follows as the cause of that event.

There is a natural tendency for the mind to personify "Cause," and to raise it to the dignity of a separate entity. This probably results from the fact that we, finding ourselves capable of voluntarily bringing about definite results, assume that there must be in every event a somewhat similar causing agency. Hence it was that primitive man referred the causation of the various natural phenomena to special Deities.

When, however, we come to examine into the matter, we find that causation is, in the last resort, a complete mystery to us—belongs to the infinite region of nescience. By carefully observing the various sequences in nature, we are able to formulate a number of laws concerning them—propositions, namely, by which we can foretell the results of certain conditions; and, as we proceed in this inquiry, these laws become more and more general—include in their sweep a wider and wider range of phenomena. By thus grouping the various sequences in Nature, our knowledge of them becomes more and more profound, and we are said to "explain" these sequences—to clear up the mystery of causation. But as a matter of fact the simplest sequence is a complete mystery to us. Why one event follows upon another none can say. We must rest content with the simple assertion of the fact.

Happily, however, the psychological mystery attaching to

cause has no corresponding practical disadvantage. It is sufficient for us to know that the same results always follow from the same conditions, and it becomes the business of the scientist to investigate the order of phenomena, to discover as many laws as possible, so that he may know what will be the result of any given conditions.

And this is the task which the pathologist has before him. He inquires into the laws which govern disease, but, be it remembered that, in stating the cause of disease, he, in the last resort, can do no more than enumerate those conditions out of which it has arisen.

The conditions from which different results follow may be spoken of as *material conditions*—conditions of matter. For, although we have no absolute knowledge of the existence of a material world (since we can know of nothing apart from our own mental states), such an assumption is, to say the least, convenient, and aids us in the practical concerns of life.

The material conditions embrace: kind of matter, quantity of matter, disposition of matter, motion of matter. Every result of which we have any knowledge may be brought about by a modification of these material conditions. Even mental phenomena may, for all practical purposes, be said to follow from them, for, although the exact relation between mind and matter surpasses all understanding, of a relation between the two there can be no doubt, inasmuch as every mental sequence is accompanied by a physical sequence, and any disturbance in the latter causes a corresponding disturbance in the former.

In seeking, therefore, the cause of disease, our object must be to discover the material conditions out of which it has arisen; and, further, to formulate as many laws relating to disease as possible.

Disease is a vital process. It may be defined as an "abnormal mode of life." This definition assumes a perfect knowledge of what constitutes normal life, but it is no easy matter, as we shall see in a future chapter, to say what is normal life. We are, nevertheless, justified in assuming an ideal or normal life. Disease may then be very readily defined as an abnormal mode of life.

And being thus an aberrant or abnormal mode of life, it is advisable, in seeking the material conditions out of which disease arises, to first ask the question, What are the material conditions out of which life arises?

To speak first of unicellular organisms. We may say that the immediate causation of life in such = "the material conditions as constituted by the cell plus all those material conditions of the cell-environment which take part in the vital inter-action." The causation of life in such an organism may be therefore represented by the formula, $S + E$.

If S be properly constructed, and if the E be fit, the vital processes go on in orderly fashion; but if either the one or the other be unfit, an abnormal inter-action occurs, and this is disease. Disease, being thus an abnormal inter-action of S and E, must be caused by some fault in S, in E, or in both.

We have, therefore, in investigating the causes of disease, to inquire most carefully into the material conditions of S and E. We cannot state these exactly, even in the case of unicellular organisms; for who will engage to define accurately the material conditions of a unicellular organism—to specify the exact relations of atom to atom in the molecule, of the molecules among themselves, or the precise movements whereby either is agitated? Our knowledge of the material conditions of the cell is, in fact, limited to its microscopic characters and chemical composition, and even in these respects it is very inadequate. The same is true of the cell-E, the exact material conditions of which we can by no means state accurately.

But although it is impossible, even in the case of unicellular organisms, to specify in minute detail the material conditions out of which the vital processes arise, this should, nevertheless, be our aim, if we wish to discover the cause of life, and the more accurately we can define these material conditions, the more complete will be our knowledge of vital causation, be it physiological or pathological.

The Environment.—*The internal-cell-E.*—In multicellular organs, the E falls into a twofold division, into (*a*) the internal-cell-E and (*b*) the external-body-E. The life of such an organism may be defined as the "sum of the inter-actions of

the various cells of the body and their respective environments," and disease in such an organism consists of the sum of the abnormal inter-actions.

Owing to the mutual inter-action of tissue upon tissue in a multicellular organism it very rarely happens that disease in such an organism remains strictly localized to one tissue. When disease of one tissue leads to morbid action in another, it is by modifying its cell-E. Such an abnormal cell-E may be spoken of as a *secondary mal-E*, while one which occurs independently of any previous morbid action may be said to constitute a *primary mal-E*. External violence and indigestible food constitute forms of primary mal-E; the presence of nitrogenous sewage in the cell-spaces in renal disease, and the diminution of oxygen in phthisis, are examples of secondary mal-E.

When the vital processes of a multicellular organism are more or less universally thrown out of gear by disease in some one part, we may define the disease as "the morbid inter-action of the primary mal-E and the tissue primarily affected, plus all those morbid inter-actions of the secondary mal-E's and the tissues secondarily affected." The name of the disease connotes the sum of these morbid inter-actions.

In studying a disease in a multicellular organism, our object should be to discover the tissue primarily affected and the exact nature of the morbid E, and to assign to each, as far as possible, its exact share in causation. We can never entirely exclude S from causation, but when we are able to satisfy ourselves that the E is distinctly abnormal, and that the S is perfectly normal (a very difficult task in many cases, owing to the difficulty of defining a normal S or E), we may, for all practical purposes, attribute the entire causation to E. But when the morbid process is facilitated by some peculiar structural weakness, practical account must be taken of this latter, and, according to our ability to gauge accurately the degree of structural weakness and the intensity of environmental abnormality, in that same proportion is our knowledge of the causation perfect.

Having fixed upon the primarily erring tissue, and assigned to S and E their relative share in causation, it is

next our business to trace out the several secondary morbid inter-actions—those, namely, due to secondary mal-E's—and to place in its proper order each of the many links of the morbid chain.

It is very seldom that the method, as above set forth, can be followed with any minuteness, for the difficulties are many and great; these are, nevertheless, the lines on which our search should be carried out.

As regards the *external-body-E,* this is far more complicated than at first sight appears. It may be classified as follows:—

I. Organic { *a.* Mental. *b.* Physical.

II. Inorganic.

The inorganic E refers to temperature, atmospheric conditions, and so forth. The organic E embraces the relations of the individual to the organic world, animal and vegetable. The relations of man to the animal world are many and complex. Those of man to man are very largely considered under the science of Sociology and Ethics, but they also fall within the province of the pathologist, for disease may be the outcome of these relations. As regard the relations existing between man and other animals, this is twofold—for first, our food supply is largely derived from the animal kingdom; and secondly, we are brought into contact, offensive and defensive, with many of the members of the animal kingdom, though in civilized countries this only happens to a slight extent.

Concerning our relation to the vegetable world, this likewise is twofold. (1) We are absolutely dependent upon it for our existence, for not only is our food supply chiefly drawn from the vegetable kingdom, but plants break up the CO_2 excreted by the animal world, and thus render animal life possible. (2) We are brought into defensive contact with myriads of unicellular organisms belonging, for the most part, to the vegetable kingdom. Indeed, our struggle against these is infinitely greater than that against the members of the animal kingdom.

The external-body-E is not only complex; it is also unstable. By a complex E is meant one that embraces many different conditions; by an unstable E, one that is not constant from day to day, or even from moment to moment.

The complexity of the external-body-E in a civilized community is shown by the fact that every separate calling has its own peculiar E; while its instability can be readily realized by remembering that, even in the case of unicellular organisms, it is impossible for any two individuals to be "similarly circumstanced in respect to incident forces."

Structure.—In considering the part played by S in disease, it is necessary to bear carefully in mind the fact that we can never exclude it from the sphere of causation, seeing that the causation of any particular disease is represented by the formula S + E.

When the S is normal (we may, for convenience, assume an ideal normality) we are justified, from a practical point of view, in excluding it from causation in certain cases, as when an individual contracts scurvy through insufficiency of vegetable diet. But, even viewing the matter from a strictly practical standpoint, it is by no means easy to do this in all cases where the S would certainly be accounted normal. If, for instance, two individuals, enjoying perfect health, be exposed for the first time to the scarlatina virus, and the one contracts the disorder while the other escapes, it is obvious that the S must be taken into practical account in stating the cause of the disease. This one case, indeed, shows us that the inclusion of S in the causation of all diseases is not a mere logical quibble.

Seeing, then, that the S takes a share in the causation of all disease-processes, it behoves us to inquire most carefully into its causation.

The nature of S depends upon two great factors—(1) Heredity; (2) Environment.

As regards the influence of E upon S, this is well shown by the different ways in which different occupations mould the individual. In estimating this influence, we must, be it remembered, start at a period antecedent to the birth of

germ and sperm. This influence is more potent the earlier it acts. The smallest alteration in germ- or sperm-structure, wrought by the subtlest force, will be sufficient to cause an alteration in the development of the embryo, this alteration increasing with every stage of development. Hence the strictest care should be taken to place the mother, prior to and during gestation, under the most perfect E, and we should moreover be particularly careful to regulate the E during the whole period of *post-partem* development. When maturity is reached, the E is less capable of influencing S.

Although the E possesses a considerable power in moulding S, it occupies a position far below *heredity* in this respect. This term embraces an infinite complexity of forces which tend to mould the individual into the likeness of the parent or parents.

Without going any further into the question, it is sufficient to say that, in the case of gamogenetic organisms, the immediate cause of heredity consists in the material conditions as constituted by the impregnated ovum and its environment. Given these material conditions, the offspring will develop into a more or less mean likeness of the parents. How germ and sperm come by their structure is another question ; but, given the proper material conditions, there is no difficulty in explaining, on the principle of causation already set forth, the subsequent developmental changes.

Be it noted, that the material conditions, as constituted by the impregnated ovum and its E, represent the *immediate* cause of the hereditary process ; but in every instance of causation we can increase our knowledge of the causative process by tracing out the remoter links in the chain of causation. Thus, if we can trace the causation of germ and sperm structure—*i.e.*, specify the material conditions out of which they themselves have risen into being—we shall possess a fuller knowledge of the causation of heredity. But indeed, in order to get a complete and philosophical insight into this marvellous moulding agency, it is necessary to cast the eye into the long past, and follow, one by one, the various steps of organic evolution. In this way we extend and

amplify the history of the causation of hereditary structure. Such a proceeding, however, would have interfered with the proper sequence of our argument ; and hence this subject will be treated of in the second part of this work, for much that is pathologically important is brought to light by examining into the evolutionary history of man.

The Principle of Structural Mean.—Inasmuch as, in the case of man, two individuals are engaged in the reproductive process, the offspring tend towards a certain mean of the two parental structures. A *certain* mean, be it noted, but not an *exact* mean, for some one or other paternal or maternal character may be prepotent.

If the E were exactly the same for each and every child born to the same parents, all the offspring would be exactly alike, save only such differences as depend upon sex—the male offspring on the one hand, the female on the other. But, owing to the instability of the E, no two children can be exactly the same. Under the principle of structural mean, the blending in the offspring of tendencies derived from the two parents has to be considered—notably, the blending of physiological with pathological tendencies, and of pathological with pathological, the latter constituting the so-called intermarriage of disease.

When the pathological tendencies are alike in both parents, the chances of the offspring inheriting the disease are very strong. Nevertheless, even in this case, there is a tendency to revert to the normal state, owing to the *vis medicatrix naturæ.* But when the morbid tendency comes from the one parent only, there is less tendency to inheritance. This may be partly explained by regarding the parents as a cross in respect of this pathological particular, for, when parents are very unlike in some one particular they may be regarded as a cross in respect to it ; and when two individuals are crossed, there is a tendency to reversion to the *status quo ante* the development of that particular or those particulars in virtue of which they become a cross. If one parent, for instance, is highly neurotic, while the other possesses a strong

and stable nervous system, the two may be regarded as a cross in respect of the nervous system, and we should expect the offspring to show a strong tendency to revert to the *status quo ànte* the acquisition of the neurotic state—*i.e.*, to a normal condition of nervous system.

The *Fixity of Structural Characters* depends, in large measure, upon their age, ancestral or individual. The ancestral age of serious pathological characters is never great—that is to say, the number of successive generations of the same family afflicted, actually or potentially, with the same serious disease is never great. And such being the case, it follows that there is a strong tendency for the offspring of parents afflicted with serious disease to revert to the normal. In like manner, in regard to characters acquired by the individual himself, the more recent the acquisition the greater is the facility with which it is cast off.

This principle of "Structural Fixity," taken in conjunction with what we know of the effects of crossing, explains, in large measure, the *vis medicatrix naturæ.*

That the fixity of a structural character largely depends upon its age, ancestral or individual, is well shown under the disturbing influence of disease, in which structural characters tend to disappear in the inverse order of their age; for almost all disease is a process of dissolution, and, be it noted, so long as the actual process of disease is going on, the dissolution is partial, for, if it be complete, there is death of the part affected, and this is not disease. Since, then, disease is a process of partial dissolution—*i.e.*, an incomplete undoing of evolution—it follows that a number of ancestral characters will tend to display themselves during disease, which must, therefore, be largely tinged with an element of reversion. The reversions, however, which take place during actual disease are very rarely exact reproductions of ancestral states, because the E causing the dissolution is probably always unlike that which was normal to the evolutionary epoch to which the reversion belongs; and, inasmuch as E is capable of modifying S, the reversion cannot be true: it will be, so to speak, a natural variation of the true reversion. We may, therefore, speak of a disease which is accompanied by distinct dissolution

as a vitiated reversion, and every complicated disease is a bundle of vitiated reversions.

The *principle of Sexual Heredity* is an important one. According to it, characters acquired by one sex at a particular period of life tend, in the offspring, to appear in the same sex and at the same period of life. This principle is not only true as regards sexual characters, but applies in some degree to each and every acquisition, whether sexual or not. Characters acquired before the period of sexual life show a tendency to be inherited by either sex indifferently, though at corresponding ages; hence, the diseases in children are in only a small degree influenced by sex. Characters acquired during the post-sexual period of life can obviously have no effect upon the offspring.

It is to be noted that the male sex takes on structural characters more readily than the female. This should prepare us for a greater variety of disease in the male.

Characters can pass potentially through one sex to the opposite sex in the offspring. In all such cases it is certain that the potentialities are kept under by a restraining influence, on the removal of which they are ever ready to become actualities.

The *principle of heredity at corresponding ages* asserts that characters acquired by one parent at a particular period of life tend to develop themselves in the offspring at the same period. The truth of this principle is amply illustrated by disease.

Such is a brief consideration of the principle of heredity. It has prepared us for the fact that heredity plays an extensive rôle in disease. In a later portion of this work we shall be in a better position to establish this statement.

Having considered the two factors of disease, S and E, separately, we must next study them together, disease being a mutual inter-action of the two; and, although this subject has been already trenched upon in this chapter, it is advisable to make some further allusion to it.

The S differs considerably in its manner of responding to the E. An E which will have no evil effect upon one individual, will in another produce the most dire results.

The tendency which a particular S has to respond abnormally to a particular E may be spoken of as "a specific structural deficiency." The less this structural deficiency, the greater is the quantity of specific mal-E requisite to call forth the disorder. In other words, the quantity of mal-E requisite to call forth a particular disorder is in inverse proportion to the degree of structural deficiency. Suppose a disease, such as insanity, be represented by eleven units, then the formula $S_1 + E_{10}$ indicates that the structural deficiency as regards insanity-producing causes—*i.e.*, the tendency of the mind-centres to take on pathological action in response to specific insanity-producing causes—is very slight; while $S_{10} + E_1$ indicates a very intense structural deficiency—one, in fact, which will spontaneously blossom into the full disease.

All of us, even the most typically healthy, respond pathologically to some forms of E, and it may therefore be thought that the term structural deficiency is inaccurate. The objection would have force, if there were one unchangeable standard or normal S, but such is not the case. If an individual, who would otherwise be accounted healthy, falls a very ready victim to a certain skin parasite, he may be said to have a structural deficiency as regards that parasite, just as an individual who is incapable of resisting the attack of the tubercular bacillus, or ague poison, may be said to be structurally deficient in respect to these agents; and it by no means follows that the proclivity to disease depends on a weakened and unhealthy bodily state. An individual having a structural deficiency as regards a particular E is, in fact, one who is *very ill-adapted to that E*, or who, as Spencer might say, is altogether out of equilibrium with it.

It does not, of course, follow that, because an organism is ill-adapted to its E, disease must ensue. All the weeding-out effected by natural selection is due to ill-adaptation; but this weeding-out is, except in the case of civilized man, in only a small degree due to disease, which is the result of very signal mal-adaptation of S to E.

PART II.

CHAPTER I.

The Evolution of Species—Natural Selection—Sexual Selection—The Action of the Environment independently of Selection.

SPECIES are evolved in a threefold manner—(1) By natural selection; (2) by sexual selection; (3) by the action of the environment, independently of either natural or sexual selection.

It is necessary to inquire how far man comes under the influence of these three methods, for a knowledge of the laws by which the human organism is built up must be of use to us in our search after the causation of disease, seeing that S plays such an important part in it. In our study of this subject, moreover, many important side issues will be raised, which might otherwise be passed over unnoticed.

The first requisite is a clear understanding of the methods in question.

Natural Selection is, so to speak, the selection by "nature" of those organisms most fit to live—that is, best adapted to their own particular environments. This is the term by which Darwin himself denoted the great law he discovered. Herbert Spencer's *Survival of the Fittest* expresses the same idea, and it has found greater favour among biologists, because the term "natural selection" seems to imply (what Darwin certainly did not mean it to do) a voluntary choice on the part of a personified nature.

There are two main factors underlying natural selection—(1) The existence of natural variations; (2) a struggle for existence. Were there no natural variations, it is obvious

that that there could be no survival of the fittest, since all members of the same species would be the same; and if there were no struggle for existence, there would be no need of such survival, since all organisms would be adequately provided for.

Natural variations are, as we have seen, an *à priori* necessity: the E cannot be the same for any two individuals, and, inasmuch as the latter is capable of influencing S, differences of E signify differences of S. Hence there must be a difference even among the individuals reproduced asexually from a single parent. Such differences in E are undoubtedly the primary cause of natural variations; but, once started in this way, they are still further increased by the method of reproduction from two parents, for, in this case, the offspring cannot be exactly like either the one or the other, and, differing from either, will form a natural variation.

Let us now inquire into the cause of the struggle for existence, and we may limit our observations to the animal kingdom. One great cause is the dearth of food; for, since organisms tend to increase in geometrical ratio, while the supply of food is limited, a certain number only can secure the proper quantity. There is, consequently, a survival of those best able to do so—of those, namely, which vary in a direction enabling them to compete successfully with their fellows. This struggle is fiercest between individuals of the same species, all of which will be struggling for the same kind of food.

But there is another element in the struggle; there is a struggle against unfavourable conditions both of the inanimate world, in the shape of excessive heat and cold and so forth, and of the animal world, in the shape of attacks of other animals, parasitic or otherwise. If an individual cannot protect himself against climatic extremes, or the attacks of other animals, he is not properly adapted to his E and succumbs, while such of his fellows as are so happily constructed as to meet the exigencies of their individual E's survive—being fitter or more in harmony therewith.

It follows that there is a perpetual weeding out of

the unfit and a survival of the fit, and thus by a gradual accumulation, during long periods of time, of favourable variations, species are in large measure evolved, the ultimate result being that each creature tends to become more and more improved in relation to its external conditions, and "this improvement eventually leads to the gradual advancement of the organization of the greater number of living beings throughout the world, the degree of advance being measured by the completeness of the division of physiological labour."

The law of "Natural Selection," or "Survival of the Fittest," is one of the greatest natural laws yet discovered, and although its exposition originally met with some opposition, it is now accepted as an uncontrovertible fact. Herbert Spencer says of it: "When once ennunciated the truth of the hypothesis is so obvious as scarcely to need proof." It has passed from the realm of hypothesis into that of law.

I would particularly emphasize the distinction between the struggle for food, or, what is the same thing, the struggle against starvation, and the struggle against the remaining adverse conditions. When we come to speak of man, we shall see what a host of diverse conditions are included under the latter, and that with him—at all events with civilized man—it is as regards these latter that natural selection plays its chief part.

Sexual Selection consists in the struggle between the members of one sex for possession of individuals of the other; and it is generally between the males for the female. Success may depend upon general strength and vigour, in which case the strongest and most vigorous males will tend to have the most offspring (we may even assume that such a struggle takes place between myriads of spermatozoa for the possession of the ovum, the hardiest and lustiest proving successful); or it may depend upon the possession of special weapons, such as the horns of the stag, or the spurs of the cock, which, therefore, tend to increase from generation to generation; or, finally, success may depend upon freedom of choice. The beautiful plumage of cock birds is due to a selection by the hens of

the most beautiful males during many generations. Speaking of the method by battle, Darwin says:—

"How low in the scale of Nature the law of battle descends I know not: male alligators have been described as fighting, bellowing, and whirling round, like Indians in a war-dance, for the possession of the females; male salmons have been seen fighting all day long; male stag-beetles sometimes bear wounds from the huge mandibles of other males; the males of certain hymenopterous insects have been frequently seen by that inimitable observer, M. Fabre, fighting for a particular female, who sits by, an apparently unconcerned beholder of the struggle, and then retires with the conqueror."*

The Action of E independently of Selection.—We have seen that the E is capable of modifying structure in a marked degree, and that any of the variations thus induced may be accumulated and intensified by selection, the organism thus becoming, *by indirect means*, adapted to its E. Wherefore Herbert Spencer speaks of this process as *indirect equilibration.*

The E may, however, work marked and definite changes upon a race, in the course of a few generations, altogether independently of selection. This process the same writer terms *direct equilibration;* while Darwin speaks of it as the *direct and definite action of the conditions of life.* Thus, the woolly hair of the negro is not the product of selection, but results from the direct action of certain atmospheric conditions, and the characteristic conformation of the true Yankee—his spare form, high shoulders, pigmented skin, and more or less hairless face, are evidently due to the action of his E, independently of selection, natural or sexual. It is indeed quite astonishing how rapidly the E may thus modify a race; any one practising among the poor of London may very soon prove this for himself. It is very easy, for instance, to distinguish between the crania of London and country-born individuals, for the bones undergo considerable change, even in the space of one generation.

In considering this action of E independently of selection, we must be careful to remember the very wide significance of

* "Origin of Species," p. 101.

the word "environment," and what a vast assemblage of diverse conditions it embraces (*vide* Part I.). Thus, as I have said, the effects of *use and disuse* are embraced under "the environment" of the individual, and there can be no doubt that species are in this way moulded in a very marked degree. To take a single example from Spencer: the æsthetic sense cannot have attained its present high development through the process of natural selection, since it is one that can only help in a very minor degree in the struggle for existence. It has grown through long cultivation or exercise, from generation to generation—that is to say, through *use*. Chiefly in this way, too, the moral sense has been evolved. The average civilized child is taught morality from its earliest age; it finds itself in a society whose very existence depends upon the observance of social law, and such cultivation, assiduously carried on through many generations, has led to the development of an innate moral sense. Thus, the æsthetic and the moral faculty have both been evolved by the continuous operation of an æsthetic and moral E on the human organism, independently of selection, at all events in large measure.

Herbert Spencer, as I have said, designates this process *direct equilibration*. It consists, in his language, "of changes of function and structure that are directly consequent on changes in the incident forces—inner changes, by which the outer changes are balanced and equilibrium restored." Even in the lifetime of an individual this process plays an important part, for in this way he tends to become more and more adapted to his E. Let us suppose twin brothers to be as like one another as it is possible for them to be: then, if one be brought up as a peasant and the other as a clerk, a steady divergence in structure will gradually ensue, each individual becoming adapted to his own particular E. We may speak of this individual tissue-alteration as *personal* to distinguish it from *racial* adaptation; and we can see how, by a summation of such personal adaptations through many generations, a race may be very considerably modified.

A study of this threefold method whereby animal organisms are evolved shows us, therefore, that evolution depends upon

simple mechanical causes (*causes efficientes*). Such a mechanical explanation is, in the language of Hæckel, "one entirely based on natural science." We are thus able to dispense with designing or teleological causes (*finales causæ*).

We have now to inquire how far the methods by which organic evolution proceeds are severally applicable to man, for whatever pertains to organic evolution may fall within the province of the pathologist, pathology being a branch of biology.

CHAPTER II.

Natural Selection—"Instinct and Reason"—Instinct a Perfect—Reason an Imperfect Guide.

I PROPOSE, then, to consider separately and in relation to man each of the methods by which organic evolution proceeds.

Natural Selection.—Herbert Spencer believes that evolution by a survival of the fittest—*i.e.*, indirect equilibrium—plays a progressively smaller and smaller part as the animal scale is mounted, until, in the case of civilized man, the process is mainly by direct equilibration. "While yet," says he, "organisms had comparatively feeble powers of co-ordinating their actions and adjusting them to the environment, natural selection acted almost alone in moulding organisms, and it has remained almost the sole agency by which plants and inferior orders of animals have been modified and developed." He believes that as fast as the "essential faculties multiply, and as fast as the number of organs that co-operate in any given function increase, indirect equilibration through natural selection becomes less and less capable of producing specific adaptations; and remains fully capable only of maintaining the general fitness of constitution to conditions, direct equilibration taking place, until at length among civilized races the equilibrium becomes mainly direct, the action of natural selection being restricted to the destruction of those who are constitutionally too feeble to live even with external aid. As the preservation of incapables is habitually secured by our social arrangements, and as very few except criminals are prevented by their inferiorities from leaving the average number of offspring (indeed, the balance of fertility is probably in favour of the inferior), it results that survival of the fittest can scarcely at all act in such a way as to produce specialities of nature either bodily or mental."

There can be no doubt that the above propositions of Spencer are in the main correct. Man will advance in the future chiefly by a process of direct equilibration. Nevertheless, natural selection plays a very important part, even in the case of civilized man—a part, too, which, viewed from a pathological standpoint, is of the utmost importance. It demands, therefore, our serious study.

In 1881 I read a paper at the Abernethian Society * on "Instinct and Reason," wherein I had occasion to draw certain contrasts between man and the dumb animals, and one of these was founded on the very small part played by natural selection among men as compared with the brutes. On reconsidering the subject, after fuller investigation, I have found that my conclusion was immature, but I propose here to give certain extracts from the paper, because, in the first place, I shall thereby avoid having to deal separately with "Instinct and Reason," a subject closely connected with the causation of disease; and, in the next place, because this proceeding will serve to emphasize certain important facts.

The grand purpose of instinct and reason is to place the individual in proper connection with the outer world. They are both the outcome of nervous action, and it is interesting to note that the nervous system develops from the epiblast or outer part of the ovum, thus clearly showing that its first and primordial function was to regulate the relations of the individual with the outer world.

Put scientifically, we may say that the essential purpose of instinct and reason is to regulate the E of the individual, to *surround him by such conditions as are best suited to his existence.* No doubt reason—I use the term in its widest sense, to include all the higher faculties of the mind—has advanced to a stage altogether beyond this; but its essential function is, and ever will be, to regulate the environment of the individual, whether he be a Shakespeare or only "common clay."

Every animal, indeed, every organism, has its particular E.

* St. Bartholomew's Hospital.

Thus, the E of the fish differs from that of the mammal, which again is different from that of the bird. Nor is this all. The E of each species of fish, bird, and mammal—indeed, of every species of animal—is different from that of any other; and it is the special purpose of instinct and reason to secure the proper E for each. If the ant had the instinct of the worm, or the latter that of the lizard, neither could provide itself with the proper E, and both would inevitably perish. But matters are so happily arranged that each animal has the inborn power of regulating its E more or less correctly.

The E of man is infinitely complex. As the division of labour proceeds in the social organism, the number of different kinds of E increases, and thus every man following a different calling is surrounded by a different E. There is not, therefore, one limited and more or less stereotyped E for each and every member of the human species, such as obtains in the case of any one species of the dumb animals.

Now, so far as the enviro-regulating apparatus is concerned, man and the brutes stand out in bold contrast, in that reason is the chief means of the one, instinct of the other. I will not here set forth in critical detail the distinctions between instinct and reason. It is sufficient to observe, that the one impels by an inborn power, which ties down the individual to act mechanically, so to speak, on a narrow and stereotyped plan; while the other is a more or less complex mental process, in which the inborn guiding voice finds but little place. The subtle psychological distinctions between instinct and reason need not, however, detain us. That there is a distinction is clear, and for pathological purposes, if for no other, it is very necessary to recognize it. And why? *Because the one regulates the E perfectly, while the other is a defective regulator;* the one places the individual amid the E to which he is best adapted, while the other frequently fails to do so. And inasmuch as disease essentially originates in improper E, this deficiency in the enviro-regulating system becomes a fertile source of disease.

Instinct is the most perfect possible guide. Few, I imagine, will deny this proposition; but lest any should, we have

an *à priori* proof of its truth in the fact that instinct has been built up very largely by natural selection; it must, therefore, as a guide, be as near perfection as possible. One is apt to think that natural selection acts solely upon the corporeal side of an individual; whereas, the function of instinct comes equally under its influence, for in the battle of life correct instinct is quite as requisite as correct bodily structure. In order that natural selection shall operate on the instinctive side of the organic being, it is necessary for the instincts to vary, and there is no reason why they should not vary quite as freely as the bodily structure; indeed, this is obviously an *à priori* deduction, since instinct is the functional expression of a certain part of the bodily structure —namely, the nervous system.

Darwin gives several examples of such variations in instincts. Thus, birds vary in their choice of nests; the magpie is tame in Norway, the crow in Egypt; and natural selection would not be slow to seize upon any variation favourable to the animal in its struggle for existence. Indeed, man himself has not failed to turn such variations in instinct to his own good account; for, as Darwin observes, he has actually built up instincts artificially, by artificially selecting such variations as are of service to him. A well-bred pointer will point the first day he is taken out; and the shepherd's dog, while quite a puppy, shows a tendency to run round, not at, a flock of sheep. If, then, man can, in the course of a few generations, build up an instinct wholly useless to the animal, and solely for his own pleasure, by artificial selection, one can well see how natural selection must tend to preserve any slight variation in instinct which is helpful to the animal in its struggle for existence; and further, how it has come about that instinct is an accurate guide, regulating the environment of the animal, indeed, with a wisdom that is well-nigh unerring.

Now, the guiding voice of reason is not, like the voice of instinct, the outcome of natural selection. The evolution of reason itself has doubtless been largely governed by natural selection; but there is a great distinction between reason as such and the *guiding voice* of reason—that part of reason,

namely, which impels to action; just as there is a great distinction between a government and the laws which it enacts. The actions dictated by reason have not the fixed and stereotyped character belonging to instinctive acts; for a reasoned act is not, like an instinctive one, the result of the impulsive prompting of an inborn voice; it is, on the contrary, the result of a complex mental process, and *this mental result* cannot possibly have come under the influence of natural selection; wherefore we are at once led to expect reason to be a less perfect guide than instinct.

With the many imperfections of reason I shall presently deal, but before doing so let me remark how important is that stage in evolution when reason first appears in full force. Although many of the brutes are endowed with reason, they are all tied down by instinct to act more or less mechanically on a narrow stereotyped plan. Man, on the other hand, is essentially a reasoning being, guided only in a small degree by instinct; so that, as I have already said, we may more or less sharply separate him from the brutes, in that *he* is governed by reason, *they* by instinct. Now, prior to the evolution of reason, such as we find it in man, we observe Nature at work in her more simple physical aspect, life being a mere complex play of chemico-physical force, and instinct (although in its higher developments largely tinged with a mental element) essentially a nervo-automatic process, the product, in a large degree, like the body itself, of natural selection. But with the evolution of reason, such as we find it in man, an entirely different order of things obtains; for whether we regard mind as necessarily linked with matter, or as something quite distinct and separate from it, the fact remains that we have in its higher creations something very different from anything which has hitherto taken part in the operations of nature*—a power, namely, which diverts the course of mere

* There can be no doubt that the evolution of mind as it appears in man, more especially in civilized man, marks an important epoch in the history of evolution, for the reasons I have given in the above text, and in order to emphasize this fact—the fact, namely, that mind henceforth exercises an important influence over natural processes hitherto more or less independent of it, and, secondly, that the process of natural selection in man is interfered with—I have kept my text unaltered, but I can now see that neither of these

chemico-physical nature. Now for the first time there occurs the clashing of two great systems—chemico-physical nature on the one hand, mind on the other. The former is no longer able to pursue her unchecked course, for man is capable of modifying the processes of physical nature at will. He cannot, indeed, suspend them—he must, as Bacon observes, rule by obeying, but in this way he can compel natural laws to work together towards a definite end, and thus not only the inanimate but the animate world is largely under his control. Man's influence over the brutes is not, be it noted, one of mere personal mastery: he can mould both plant and animal forms *at will*, namely, by modifying their environment and by artificial selection. For these reasons, if for no other, the appearance of mature reason, such as we find it in man, marks an important epoch in the history of evolution. But two other noteworthy effects must be mentioned, and they relate to man alone. (1) Reason being a far less perfect guide than instinct, man, forsaken by the all-wise guide, but too often finds himself plunging in the dark, and unwittingly rushing into destruction. (2) Owing to the evolution of reason in man, he is to a very large extent exempt from the operation of natural selection, and, inasmuch as this process is continually weeding out the inferiors and securing the survival of the fittest alone, the effect on the human race must be injurious. I will consider the latter propositions presently. Meanwhile, let us examine the former, namely—Reason is a less perfect guide than instinct.

conclusions is altogether correct. In the first place, the distinction above drawn, between "chemico-physical nature" and the voluntary operations of the mind, though useful, is arbitrary. Now that I have become better acquainted with psychology, I cannot do otherwise than accept the doctrine of necessity, and hence the sharp distinction I have drawn between a voluntary mental impulse and a chemico-physical process does not exist. The apparently voluntary efforts of the mind are nothing else than the expression of chemico-physical nerve change, the "voluntariness" being a delusive creation of the mind. It is quite obvious, in fact, that the doctrine of necessity is inconsistent with my assertion that "with the evolution of reason we have a something quite distinct from chemico-physical nature." Secondly, although doubtless there is some interference with the operation of natural selection among men, I cannot doubt, on maturer thought, that natural selection here still operates very potently, as I shall show hereafter.

It is necessary to remember that reason has a far more difficult task before it than instinct, for, along with the development of the higher mental faculties, society has become more and more complex, and thus civilized man finds himself in the midst of a highly complex E. Moreover, this E is not fixed and stereotyped like that of the brutes, but ever variable, and man is continually encountering combinations of circumstances which have never occurred to him before. Reason has, therefore, to serve as guide through an E which is both complex and variable. Furthermore, the E of man comprises an abundance of luxuries, many of which are tempting and fascinating sources of evil, and lure to destruction, just as a flame entices the moth, or as the false beacon of old lured the passing vessel to its doom. To safely guide an individual through all the intricacies, temptations, and dangers of a civilized E, is indeed a difficult task for reason. On the other hand, the E of the instinct-led brute is far simpler and more stable, for instinct compels the animal to remain in certain fixed and well-trodden grooves; wherefore, its task is comparatively easy. But altogether apart from the question of difficulty, instinct is as a guide much surer and safer than reason. We have seen why instinct is a sure and perfect guide; let us now inquire why, in this respect, reason is so far inferior to it.

The knowledge of how to act upon any given occasion is largely based upon man's experience, both individual and ancestral—*i.e.*, he learns personally what is good and bad for him, and this experience is often dearly bought; and he further profits by the accumulated experience of those who have gone before him. This experience is transmitted from generation to generation by word of mouth and written record—not, in the way of instinct, by direct heredity. Now, when a man finds himself in an altogether new position, a position which he has not experienced before, he must, unless the experience of others be available, fall back upon the guidance of reason, pure and simple—that is to say, *intellect*. But this often fails him. To set forth in critical detail the imperfections of reason would be to write a large volume. Certain it is that every one does not know how to reason correctly on even the

most simple questions. A perfect reasoner, indeed, is very rarely met with. Our own medical literature affords abundant proof of this, and this work is doubtless no exception. But, apart from the fact that reason may fail to work properly, there is the additional fact that the material for reason may not be to hand—we may be ignorant of the data from which to derive the proper conclusion. Wherefore, in order that reason shall on all occasions give a correct result, two things are requisite—man must be acquainted with every natural law, and he must be gifted with perfect reasoning power.

By the aid of experience and reason, however, he can frequently learn what is the proper course to take. But here another imperfection arises: he may *know*, but he may not *choose* to be guided by his knowledge. Perfect knowledge of right and wrong does not imply virtue. Socrates held knowledge to be virtue, but we may, with more correctness, say virtue is the correct application of, or the proper acting up to, knowledge.

When an individual fails to act up to his knowledge in a matter relating to his personal well-being, he is said to be *imprudent* (Bain). An imprudent man is one who is unable to see that the evil ultimately resulting from a present pleasure quite outweighs it, and that the algebraical sum gives a minus quantity—he cannot correctly weigh between a present pleasure —*e.g.*, unwise eating—and future misery—dyspepsia. Imprudence is therefore a *mental defect*, or a defect of *reason*, employing this word as an antithesis to instinct, and as signifying all those mental forces, other than the instinctive, which impel to action (not as signifying intellect, which is perhaps its proper signification).

"No one who pays any attention to this subject . . . . can fail to see that the vast difference which exists between what actually is and what might be depends, not so much upon want of knowledge, as on want of action. Ignorance, no doubt, has much to do with sickly lives and early deaths, but surely the indisposition and want of will to act on what is clearly understood has much more to do with the presence of disease and premature decay. As an instance of this, let us refer for a moment to the influence of intoxicating liquors on the population. Is the absence of any effort to control or mitigate

the evil due to any doubt of its effects on life and health? Has not the potency of alcohol as an active agent of various diseases, as the chief cause of that condition of body and mind in which both will easily succumb to trivial forms of mischief, been established beyond all question? And then is it exaggeration to say that, if the abuse of alcohol were unknown, half the sin and three-fourths of the poverty and misery of the world would disappear from it? Or, for another illustration, let us recur to the subject of infection. Do we avail ourselves of what is clearly known, and even generally recognized, of the laws which regulate the propagation of infectious diseases? Are we still waiting for the necessary knowledge? When will the time for action come?" *

Wherefore we must conclude that man's guide is imperfect: first, through his deficiency of knowledge, whether gained through experience (personal or otherwise) or by an intellectual process; and, secondly, through his inability † to act up to what knowledge he has.

Now, inasmuch as instinct secures to the dumb animal a more perfect E than that with which reason provides man, it follows that the brute creation is less afflicted by disease than man, for an improper E is the great cause of disease. Disease, no doubt, does exist among the brutes, as it does even in the vegetable world; it is, indeed, as I have already pointed out, an *à priori* necessity. Nevertheless, there is a wide difference between the standard of health in man, more especially civilized man, and in the brutes.

It is not fair to select the domesticated animals as standards of comparison, because they have, in many cases, been largely moulded by artificial selection. Not only have their instincts become vitiated in this way, but they have further suffered from prolonged domestication. The common domestic cow, for instance, is a very different being from its wild progenitor,

* W. S. Savory, "The Book of Health," pp. 96, 97.

† A believer in the "Freedom of the Will" would prefer the word *failure* here, and this word would better harmonize with the statement made on p. 198, that a man "may *know*, but he may not *choose* to be guided by his knowledge," since this statement implies a freedom of choice; but whether we have or have not such freedom of choice, the fact that we do not act up to our knowledge must be accounted a mental defect—"a defect of reason" as distinguished from instinct.

P 2

alike in its instincts and bodily conformation. The product of artificial selection, confined for long periods, and fed upon artificial food, what wonder that this pampered creature should suffer from acute flatulent distension if let loose upon a field of fresh clover! Yet I imagine that such an accident rarely, if ever, occurs in the wild state. The instincts of animals may, however, be rapidly corrupted by domestication. Jumbo, the great elephant, was said to be very fond of alcohol, and almost all our domesticated animals may be educated into liking articles of diet quite unlike those they feed upon in the natural state; thus, most of the vegetable feeders, *e.g.*, horses and pigeons, can be taught to eat meat, and I frequently see a pet lamb which eats fat, tea-leaves, and many other strange things with great eagerness.

CHAPTER III.

Natural Selection (*continued*)—The Influence of "Reason" upon Natural Selection.

THE most serious accusation to be laid at the door of "reason" is that it has rendered the law of natural selection more or less inoperative among men. If this be true, it is a very serious indictment, since by natural selection there is a continual weeding out of the evil from the good, and surely the cessation of this beneficial process must work very great harm upon the race.

In the following observations let me remind the reader that I am repeating arguments used in the paper already alluded to—arguments which certainly must often have been used before, since they would occur to any one who would take the trouble to think the subject out for himself; indeed, I have often heard similar arguments used in ordinary conversation. I shall presently show, however, that they do not represent the complete truth.

In studying the effects of natural selection upon the animal organism, it is advisable to regard the latter in a twofold aspect —(1) from the corporeal, (2) from the instinctive or mental point of view, and the one is as important as the other.

First, as to the corporeal side. Does natural selection, in the case of man, secure the survival of those corporeally the most fit? Assuredly not. Do the strongest and healthiest always survive their inferiors, and hand down their superiorities to posterity? Alas, no! for it is a matter of common notice that the fine young fellow "goes to the dogs." He poisons his blood with drink, or with a yet viler thing, thus wrecking in a single generation a beautiful organisation which has slowly and laboriously evolved through myriads of generations, each one of which, be it remembered, has had the good

fortune to vary in the right direction and to secure the proper E.

Every man will do well to cast his mind into the past, and essay to picture to himself the fierce conflict which has raged from the beginning to the end of his evolutionary career. Let him travel back through the long ancestral line until he arrives at his unicellular ancestors. How countless the generations! and yet each individual member in the long line has been subject to enormous competition, has had to struggle with countless adverse conditions, and has emerged successfully from the conflict. Out of such a conflict have we risen. Each one in our long line of ancestors has been chosen from very many other individuals; so that in every successive generation the birth of every animal into the world becomes more and more a matter of "chance"*—results more and more from an inconceivably complex assemblage of pre-existing combinations.

Surely, therefore, some dignity is attached to the existence of every animal, and to man above all others. The thought may well kindle a feeling of pride in every healthy man, for is he not the expression and the result of a series of successful conflicts extending back into the dim past—to the period, in fact, of life's first evolution? Thus does the biologist soliloquize when he contemplates a beautiful animal. How painful a thing is it to him to see a healthy man, the chosen of the chosen, damning and wrecking his beautiful organization, and leaving no likeness of himself to future generations, or, if a likeness, one that bears upon it the curse of his misdeeds!

Nor is it only by the indiscretions and misconduct of the individual that the long slow work of ages is wasted. War, too, interferes with the process of natural selection, reversing it, in fact, and weeding out the healthy and vigorous, while the halt and maimed are left at home to perpetuate the race. Already this weeding out of the "fittest" has worked with terrible effect on the physique of the French nation. Where, now, are the stalwart warriors who formed the body-guard of the first Napoleon? And it is not merely on his physical side that man

* I use the word "chance" here in the popular sense.

has suffered since natural selection has been interfered with by the course of European history. His mental side has suffered too. As Mr. Galton remarks, "all the finest intellects, and the most modest and gentle natures, fled to the convent from the disturbed and terrible world," which thus underwent double loss, its best and noblest withdrawn from it, its basest and most ignoble left to raise up the future generations.

It is clear that in modern civilized life the elimination of the healthy from the diseased is not of the rigorous primordial kind. Very many sickly and diseased people, who in a wild state of nature would be rapidly weeded out, survive the procreative period, and leave offspring, who tend to inherit the same diseases. This new order of things is the outcome of *morality*, which has evolved *pari passu* with the development of society; for morality is a necessary concomitant of social development. Civilized man, as at present constituted, would never suffer natural selection to run its merciless course wholly unchecked. In a litter of pigs, the weakest is destroyed, but in the young human family does not the sickly, crippled child absorb an extra share of the mother's love?

> "His mother, too, no doubt above
> Her other children him did love;
> For, was she here, or was she there,
> She thought of him with constant care,
> And more than mother's love."—WORDSWORTH.

Morality cries out against oppression of the weaker; far from crushing them under foot, it bids us help them, it kindles our sympathy for them, and thus asylums are founded where many live on, who, otherwise, must needs die. The well-ordered mind shrinks from the thought of taking human life, or of suffering a fellow-creature to die without help; such store, indeed, do we set on life, that we exhaust every effort to prolong it, even though it be but one long agony. Nay, when certain death is near at hand, we still strive to delay the fatal moment, if only for a few seconds.

Let us now consider the effect of natural selection on the mental side of man. We may broadly say that in his case natural selection operates chiefly on this side. We must remember that in man the strength of intellect far transcends

that of the body: which man do we account the stronger, the muscular or the intellectual—which in the battle of life comes to the fore? Among savage communities bodily and mental superiority take about equal shares in giving one man an advantage over his fellows, but among civilized peoples, a man who is, so to speak, a mere walking brain, can command the destinies of nations. Thus, among the latter, natural selection is not so much a matter of life or death as of personal and social well-being. If, however, man had no morality prompting him to help the weaker, we may be pretty sure that the fool would go to the wall, not only in the sense of sinking in the social scale, but in the matter of life or death. Intellectual superiority would be the great criterion of fitness if—as it probably would—the absence of morality did not prevent this, and thus, in the course of time, there would be an accumulation of mental superiority by natural selection, and consequent rapid mental evolution. As it is, there is a tendency to remain at a certain fixed mean, intellectual and physical, for the clever man marries a stupid wife and the clever woman a stupid husband, and, in like manner, physical strength unites itself with physical weakness.

CHAPTER IV.

Natural Selection (*continued*)—The purely Accidental Causes of Death—Mal-Environments—The Necessarily-Fatal Environment—The Not-Necessarily-Fatal Environment—The Necessary Mal-Environment.

THE distinction I have drawn in the last two chapters between instinct and reason is a very necessary one. There is no manner of doubt that the one is a safer guide than the other, and it is equally true that the moral nature in man offers a severe check to the operation of natural selection. My object has been to throw these two facts into bold relief. Having done so, it is now necessary to study in greater detail the operation of natural selection in man, and in this inquiry we must have an eye chiefly to its pathological side.

The fact that man has been many thousands of years upon the earth, while the entire population thereof is only a little more than 14,000 millions, shows us that the checks to increase must have been enormous. If the world were peopled afresh from two individuals, all checks to increase being removed, the present population might be reached in a comparatively short period of time. Now, it is at once manifest that in this vast destruction of life in the past there must have been a survival of the fittest. Wherefore, it is *à priori* evident that the principle of natural selection has played some considerable part in the evolution of the human race—the evolution of man from the ape-like man.

No doubt, in many cases, the survival has not been of the fittest—to wit, when death has been due to sheer accident; but we may be quite sure that, on the whole, it has been the fittest which have survived and given to posterity the largest number of offspring. The checks to increase are, of course, far the greatest among savage communities, whose population may not increase during many centuries. In many civilized communities, on the other hand, the population is steadily increasing,

the checks to increase being more or less inoperative among them; indeed, since the advance of sanitary science, the population in some cases has been increasing by leaps and bounds, and in such countries natural selection cannot be so rigorous as among those savage communities where the population is stationary.

The checks to increase consist of such violent agencies as famine, warfare, accident, and infanticide, or of the more insidious operations of bad hygienic surroundings, and the many different forms of disease which result therefrom.

Among savage tribes the larger proportion of deaths is probably due to violent causes rather than to disease, but the latter is certainly the chief cause of death among civilized peoples, although warfare still plays a sadly prominent part.

Let us now see how far these checks to increase result in the survival of the fittest.

All deaths occurring before or during the procreative period of life, save such as are due to *purely accidental causes*, fall under the law of natural selection, for they are deaths of the unfit. Unfit individuals are thus weeded out and prevented entirely or in part from transmitting their unfitness to posterity, while the fitter survive and propagate the species.

By "purely accidental causes," I mean such as would inevitably lead to the death of anybody exposed to them, and which are, moreover, in no way due to personal carelessness. For, if the mental self be responsible for the death, the individual may be regarded as *mentally unfit*, the fault residing largely in himself; and if the E be one which would not cause death in every one, death cannot in that case be said to be strictly accidental, since it is due to an individual weakness as regards a special E,* a weakness which is not shared by all others. If, therefore, personal weakness, mental or physical, plays a part in causing death, we cannot say that the death is due to accident, and in all such cases adaptation is possible by a survival of the fittest.

The causes which *inevitably* lead to the death of each and every individual coming under their influence are violent and non-violent: the former include, among others, traumatism,

* See chapter on "Normality of S and E," Part III.

poisoning, heat, starvation, suffocation, and drowning. If a person be killed in a railway accident, deliberately poisoned, burnt to death, starved, drowned, or suffocated by another, he may be said to have met with a purely accidental death; but if, on the other hand, through a careless neglect of proper precaution, through deliberate purpose or uncontrollable impulse, he break his neck, poison, burn, starve, drown, or suffocate himself, the cause of death resides in large measure within himself; it is due to an imperfection in his mental self, rather than to the E—others mentally fitter being naturally selected.

The non-violent agencies include, among others, all such as are comprised under the term insanitation. Vast numbers of people yearly succumb to these, and in at all events a large number of cases the fault is not their own—is not due to personal carelessness. Thus, many occupations are necessarily fatal, if not to the first, at all events to the second or third generation following them. Deaths thus caused are purely accidental, since the individual is in no way personally responsible for them, and since, moreover, the E is necessarily fatal to all. But it is far otherwise with those—and their number is large—who willingly transgress the laws of health. Here, again, we are dealing with the mentally unfit, who are thus weeded out from the mentally fitter.

In order to properly understand the influence of natural selection it is necessary to classify E's. As will be pointed out in a future chapter, there is no such thing as a fixed and unalterable normal E for all. The E can only be considered in relation to the individual. It must be regarded as normal if the individual is capable of enjoying perfect health within it, but only so far as that individual is concerned; and it may be regarded as a *mal-E* if the individual cannot live healthily in it. Roughly speaking, we may regard an E as a mal-E when it works an ill effect upon all men, or upon a limited number of men who under a different E can live healthily.

Now these mal-E's fall into two important classes—(1) The necessarily-fatal-E; (2) The not-necessarily-fatal-E. By the former I mean an E which is necessarily fatal to each and every member of the human race; by the latter, a mal-E, which produces ill effects in some, but not in all, or, at all

events which does not cause death in all. The one is incompatible, the other compatible, with human existence.

Now, it is obvious that natural selection only operates as regards the not-necessarily-fatal-E, for if the E be inconsistent with the permanent continuance of the race, there is no natural selection in the proper sense of the term, natural selection implying adaptation; but by natural selection a race may become adapted to the not-necessarily-fatal mal-E's. I was careful to point out that a strictly accidental death has two characteristics—first, that it is independent of carelessness or other mental deficiency on the part of the individual; secondly, that it is due to an E which must necessarily lead to the death of any one exposed to it. Such an E corresponds to what we have called the necessarily-fatal-E, with this difference that it signifies an E which necessarily causes death in the first generation, while the necessarily-fatal-E of which I am now speaking is one which need not cause death in the first generation, but which sooner or later leads to extinction.

While speaking of mal-E's it is necessary to observe that no one can pass through life without meeting with a certain quantity of mal-E, such as sudden changes in the weather—damp, fog, and so on. We may speak of this as the *necessary-mal-E*. The quantity of this varies, of course, for all, but there is a certain mean or average quantity from which none can escape. It is true that it can be reduced to a minimum, but it can never be quite obliterated, and it is only a certain number who successfully run the gauntlet of this necessary-mal-E; a large number succumb, whether it be from a cold or a bacillus: and these individuals are weeded out, being imperfectly adapted to an average E. Take the case of children, for instance. Athough, doubtless, their survival or non-survival depends rather upon differences of E than of S,* yet it may, and often does, depend upon differences in the capacity to resist certain noxious agents. Thus, one child may succumb to diphtheria, a second to tubercle, while two others, to all appearances equally exposed to the poisons of these disorders, survive. We may suppose that the two former children have been

* The large mortality of children among the poorer classes of large cities is due, not to differences in the children, but to differences in the E.

weeded out, by reason of their having less capacity than the others to resist the average or necessary-mal-E. On the other hand, such premature deaths may be due not so much to specific inborn "tissue deficiencies," as to excessive quantities of mal-E, and, in considering this E, we must not merely include the specific E which caused the disease, but one extending, it may be, over a long period.

CHAPTER V.

Natural Selection (*continued*)—Deficiency of Food only an Indirect Cause of Death in Civilized Communities.

When considering the struggle for existence among the lower animals, we saw that it was of two kinds—(*a*) a struggle for food; (*b*) a struggle against adverse conditions having no connection with the procuring of food. The chief cause of weeding-out among the lower animals is probably the inability to secure sufficient food, and the same is true of savage communities. Unable to develop the natural resources of the country (the most degraded tribes being even incapable of tilling the soil), these find their supply of food a fixed limited quantity; some check to the tendency to increase in geometric ratio is therefore absolutely necessary, and the two most potent checks are probably war and infanticide; occasionally, also, famine, floods, and cold cause great destruction of life.

In civilized communities, however, the deficiency of food is no such dominant factor, the chief cause of death lying in conditions having little or no *immediate* connection with the procuring of food, conditions which we shall have occasion presently to consider more particularly. No doubt the struggle for food is an important factor even among civilized peoples, but we might, in this case, more correctly say that the struggle is for wealth rather than for food alone. There is, indeed, a perpetual struggle for wealth and the benefits which it brings, and no doubt in this struggle many are actually destroyed, body and mind breaking down under the effort, and death being thus caused *indirectly* by it; but in the vast bulk of cases it is not a matter of *immediate* life or death, and the principle of survival chiefly applies in the sense that, in the struggle, some succeed, while others fail, *in securing wealth and*

position. Comparatively few in civilized communities die from sheer want of food, the necessities of life being placed practically within the reach of all. Famine does unfortunately occur from time to time among such, and when this happens there is probably in some degree a survival of the fittest; for though the provident, as well as the improvident, are apt to be swept away by a widespread famine, the former would on the whole stand a better chance of surviving.

Thus, owing to the keen competition for the necessities of life among the lower animals, and among savages, *many must die*, but in civilized communities *few need die* from this cause directly.

I say that among the civilized the actual struggle is rather for wealth than for the actual necessities of life, since food is, to all intents and purposes, placed within the reach of all; but indirectly wealth—and I do not necessarily mean immense wealth—tends to increase the chance of survival. In the country many of the poor live to extreme old age, yet I doubt not that, even here, the moderately wealthy rear a larger number of offspring than the extremely poor, who are unable to bestow that care upon their children which is absolutely necessary to successful rearing. In towns, however, the difference in mortality between rich and poor children must be very large. This fact is, I believe, well known to insurance companies. It is possible, indeed, that the lower classes are more prolific, be the causes what they may; but, as we shall presently see, the poorer parts of large towns necessarily lead to extinction, if not in the first, at all events in the second or third generation, so that the excessive fruitfulness of the poorer classes does not lead to a correspondingly larger survival. The wealthy congregate around the large squares, or fly to the suburbs, where the conditions of life are more favourable. There can be no doubt whatever that in large towns these latter stand an infinitely better chance of survival than the poor, not only because they are less apt to be carried off by starvation, but because they can command more favourable health-conditions. Now wealth for the most part signifies ability. When the individual has acquired wealth for himself, such acquisition obviously signifies some special aptitude on his part, and when wealth is inherited the inheritor

is apt to inherit also the mental aptitude of the ancestor who actually acquired it.*

Seeing that scarcity of food is very rarely a *direct* cause of premature death among civilized communities, let us now inquire into those other conditions with which animal organisms have to cope? They are countless. Foremost among them must be reckoned that long array of evils due to insanitary conditions. We have also to take into account peculiar atmospheric conditions, extremes of heat and cold, and innumerable other injurious conditions.

Such injurious external E's obtain frequently enough among the lower animals, and are a fruitful source of disease in them, wherefore it may be said that there is a perpetual struggle against these conditions, those animals which are least capable of withstanding their evil effects being weeded out, the "fitter" surviving; but injurious external E's are far less numerous for the lower animals than for man, and, notably, civilized man. The brutes are tied down to a comparatively limited plan of action by a simple instinct. They are, in short, surrounded by a comparatively simple environment, but as instinct is replaced by the higher developments of mind the environment is rendered more and more complex, and disease-causing agencies are multiplied a thousandfold. For, as mind evolves, the social division of labour proceeds: we have this man following one calling, that man another, till in a complex social community such occupations are to be reckoned by the thousand. The environment of each of these, be it remembered, is distinct: it is distinct for the sweep, navvy, knife-grinder, butcher, publican, acrobat, sempstress, actor, painter, lawyer, doctor, and the countless other callings which help to build up the highly complex fabric of civilization. Some of these occupations are perfectly consistent with health, but many tend directly or indirectly to excite disease, and a large volume might be written on diseases peculiar to special callings.

Again, there are many forms of mal-E in a civilized society to which large numbers are exposed, independently of calling, such as drink, sexual excess, damp dwellings, draughts, absence

* These remarks do not apply so forcibly to individuals who inherit their wealth by entail from a far-off ancestor.

of sunlight; pestilences, moreover, are apt to arise where many human beings congregate, unless special precautions be taken. Now, primitive tribes are less exposed to these several forms of mal-E on account of their wandering habits, but they and even the lower animals may be carried off by epidemics when their number gets too abundant. This, for instance, not unfrequently occurs in the case of grouse and salmon. Wherefore it is obvious that man has to struggle against many unfavourable circumstances besides the mere absence of food, and it is these which cause the active weeding-out of civilized man, not the scarcity of food. Although poverty does not often entail death from sheer starvation, it may lead to exposure to a variety of mal-conditions, and so a very active elimination occurs among the poorer classes, especially in large cities.

CHAPTER VI.

Natural Selection (*continued*)—The Frequency of Natural Variations in Man—The Influence of Natural Selection on the Mental Side of Man.

SINCE natural selection deals with natural variations (for in this process unfavourable variations are weeded out, while favourable variations stand the best chance of survival), it is worth while inquiring how far these occur in the human race.

It is well known that variations are far more common among domestic animals than their wild congeners. Animals in the wild state become by degrees adapted to their E, which, be it noted, varies but little from generation to generation; it possesses, namely, the important element of *stability*, and more or less perfect adaptation to a stable form of E is only a matter of time. When, however, a wild animal is domesticated, the E is suddenly altered, and variations appear in abundance. The E now differs in two respects: in the first place it is far more complicated, in the second it is more unstable from generation to generation. In spite of the greater complexity, however, we may safely assert that more or less perfect adaptation would sooner or later occur—the variations becoming less in number and degree—if only the E remained exactly the same during several successive generations.

We may be sure that variations are not so abundant among savage races as among civilized peoples, because the E is both more simple and more stable, being, in fact, more or less identical during successive generations. How different is the case of civilized peoples! Not only is their E infinitely more complex, it is also immeasurably more unstable. The complexity of the social fabric increases *pari passu* with the division of labour, each special calling having its own par-

ticular E, and the instability of the E is sufficiently evidenced by the fact that successive generations of individual families follow in a large degree different callings. Wherefore we can, *à priori*, conclude that civilized people exhibit variations greatly in excess of primitive tribes, and the greater the number of natural variations the greater the room for unfavourable variations, and therefore for disease. The converse is also true: the greater the number of natural variations, the greater is the room for favourable variations. Hence it is that prodigies—*i.e.*, individuals, who in some respect, or respects, stand head and shoulders above their fellows—are probably more common in civilized communities.

Similarly, we may be equally sure that owing to the comparative simplicity and stability of the E, variations are less numerous among simple agricultural communities than among the inhabitants of towns.

A further cause of increase in the number of variations occurring in civilized communities is the commingling and intermarriage of different races; for crossing is a recognized cause of variations.

Variations, then, being so abundant among civilized peoples, we may be sure that natural selection will be active.

In our study of this subject from the pathological point of view, it will be convenient to arrange the variations under four heads. Man may be regarded as a two-sided organism—(1) as a thinking being, (2) as merely corporeal—and he may vary in one or other of these respects. Thus we have two great classes of variations—(1) mental variations and (2) bodily variations. Although it is convenient thus to make a distinction between the mental and physical sides of man, the distinction is more or less artificial, owing to the close interdependence of the two. Mind is in some way connected with matter, more particularly with nervous matter: it is dependent upon the nervous organization of the cortex, and all mental variations are in reality structural variations of a certain portion of the nervous system.

Setting aside this objection, however, the division into mental and bodily variations admits of a further subdivision, and one especially important from the medical point of view—

namely, into physiological and pathological variations. Thus, we have four kinds of variations in all—physiological and pathological mental variations, physiological and pathological bodily variations—and these four may be typified by the following examples—geniuses, idiots, giants, cripples.

I shall first speak of mental variations, and shall endeavour to discover how far natural selection operates upon them. In my essay on "Instinct and Reason," already quoted, I came to the conclusion that natural selection operated solely on the mental side, and that the selection was not so much a matter of life or death, as the sorting of society into various classes. Both of these conclusions were wrong, for natural selection is not only busily at work on the moral fabric of man—it operates very actively on the physical side also. Moreover, its effect upon the mental side is not only to cause an unequal distribution of wealth, but to lead to an active weeding-out of certain mental types.

What are these types? In the first place individuals of distinctly unsound mind have far less chance of leaving offspring than the sane. They are less likely to be married, and this for many reasons. During the latent stage of insanity, no doubt, some get married, but when once the individual has been actually insane the chances of matrimony are very small. Few, indeed, would marry such an individual. Perhaps there would be less objection among some of the lower classes than among those higher in the social scale, yet, even where the objection may be less strong, there are many checks to such unions. For a large number of the insane are under restraint, and, even if not actually under restraint, they are, for the most part, placed outside the pale of society. Again, it is a well-known fact that the criminal class is very largely constituted of individuals showing distinct mental deficiency. They come of neurotic families, and are, in fact, pathological variations. Now the checks to the increase of this class are very great, for much of the criminal's life is spent in prison, and a number of the most depraved kind are executed; indeed, the destruction of these poor wretches in the past has been terrible.

Further, among the sane, mental aptitude plays a distinct

part in determining whether or not an individual shall leave offspring. Some are so mentally constituted as to prefer single life, be it from constitutional coldness, the lack of domestic instinct, the love of a restless and roving life (which is a relic of the past), or what not. This class tends to be weeded out, members of it leaving few or no offspring. Again, the sober, steady, persevering man is better able to support a wife, and is, therefore, more likely to marry, and to transmit these qualities to posterity, than an individual possessing the opposite characteristics. Unfortunately, this rule does not apply with any great force to the lower classes, whose fruitfulness seems to be in direct ratio to their extravagance and imprudence. Nevertheless, as I have already pointed out, although the poor are very prolific, this class stands on the whole less chance of handing down offspring to remote posterity, for in large towns the E of the poor is the "necessarily fatal," and even in the country the comparatively wealthy stand a better chance of rearing a numerous progeny than the very poor.

But over and above this weeding-out of criminals, of those who, from other mental causes, do not marry, and, finally, of those who, although married, stand, on account of poverty, less chance of rearing a healthy offspring which shall continue fruitful in a remote futurity, there is a terrific weeding-out of *those mentally unfit to cope with their environment*: not only of those who break the laws of the land, but of such as voluntarily transgress the simple canons of health. Man, as we have seen, differs very largely from the brutes in that he possesses greater controlling power over his E. Now, if he *voluntarily* places himself amid a disease-causing E, he may be said to be incapable of coping with his E: it is not the E that is so much at fault as himself. All individuals are surrounded more or less by such pathogenic E's. Some avoid them (for I am only speaking of such as are avoidable), others plunge voluntarily into their midst. To recount, one by one, the many ways in which individuals can thus damage their health, were an endless task. They consist, for the most part, of excesses, whether of eating, drinking, or sexuality—debauchery, in fact. Individuals leading such debauched lives tend to be weeded out, it may not, indeed, be in the first

generation, but, if successive generations of the same family thus inordinately indulge themselves, complete family extinction must sooner or later result. Let any one glance around and he will see the truth of this: not only will he find isolated individuals, young and old, thus destroying themselves, but he will discover whole families on the rapid road to extinction.

In this way there is a perpetual weeding-out of those mentally incapable of resisting certain pathogenic E's, and be it remembered that this result lies chiefly with the individual; its cause is structural, and due to some deficiency in the brain cortex. I say the result lies "chiefly" with the individual, because we must take into account the amount of pathogenic E to which he is exposed. Some are carefully sheltered from injurious moral influences; others are brought up in a very hot-bed of immorality; and if the one escapes unhurt, while the other falls, it is not necessarily because the former possesses greater resisting power. Nevertheless, the element of individual resistance must be taken into account. A member of a civilized community has to contend against certain mal-E's, and, if he cannot resist their evil influences, he is weeded out, being, in fact, structurally unfit to cope with his E. Drink is a more terrible poison than any zymotic virus—a more deadly enemy than the most powerful armies, and he who cannot withstand its alluring influence—he who cannot withstand the mal-E, "Drink"—alike with him who is incapable of resisting the evil effects of the ague or typhoid poisons, succumbs to the inexorable law of natural selection, and in this way adaptation to the complex E of a civilized community is perpetually going on.

I do not for one moment wish to suggest that this weeding-out process should be allowed to run its course unchecked. It is the duty of those in authority to render the E as harmless and innocent as may be, to bring up children in a beautiful morality, and to so strengthen the mental self, that the individual may escape unhurt from the many moral evils which in spite of care must always surround him.

So much for the actual weeding-out process, but, as already observed, natural selection also operates upon the mental side of man without directly leading to actual destruction of life—

namely, in causing some to rise and others to sink in the social scale. In all the ordinary affairs of life, we find the principle of "the survival of the fittest" in full play, and I cannot here refrain from extending my observations on this head, although, by so doing, I shall be travelling somewhat beyond the scope of this work.

Just as the physical self and the physical E coming into contact, act and react upon one another, so also do the mental self and the mental E. The latter pair work of course in a physical medium, for mind is inseverably connected with matter, and the mental E operates by impressing the organs of sense through a physical medium. Now the mental success—that is to say, the intellectual or moral success—of any individual is the outcome of the mutual inter-action of the mental self and the mental E, just as the success of an individual, from a physical point of view, is the outcome of the inter-action of the physical self and the physical E. A man's success or failure in life is not a matter of chance, but the outcome of fixed and immutable law. The more we study the career of any individual the more we shall be struck with this fact. If we observe a rival outstripping us in the race of life, we are sometimes apt to attribute his greater success to greater luck, or, in more scientific terms, to a more favourable mental E; and we are the more disposed to do so, if we have ourselves achieved but a small measure of success. But if we closely scrutinize the character of our rival, we shall find in him all the elements of success, intellectual and moral qualities which we ourselves do not possess. These qualities, individually, may appear insignificant, but collectively, they make up a force which surely, steadily, irresistibly, wins the goal. Whether a man achieve a proud position in life, or whether he prove an abject failure, we may safely assert that his success or failure is the logical and inevitable result of the mutual inter-action of his mental self and mental E, and that that result might be calculated with as much mathematical exactness as any purely mechanical problem in physics, did we possess the necessary insight.

The part played by the E in the result is no doubt important, but we must not overrate it. "Some men," says

Shakespeare, "are born great." We may interpret this in two ways. An individual of exalted position, such as a hereditary king, may be said to be born great—but his greatness is only external, nominal ; or we may suppose the phrase to mean that the individual is born great in the sense of having a great intellect, which is bound to do great things. Of this intrinsic greatness, no better example can be given than that of Shakespeare himself.

Then "some achieve greatness." These are they who, starting in a mediocre position, lift themselves into a high one. In such cases the mental self is strong, and the mental-E more or less favourable. We may liken one of this class to a tree which has grown to lofty and beautiful proportions in a natural soil ; while those who have had "greatness thrust upon them," are, I take it, such as have been surrounded by a very favourable E, and we may compare them with the plant which has been carefully and artificially nurtured—which has been surrounded by the most favourable E.

I have said that the success of an individual in life depends upon the nature of the mental self, and of the mental-E. For the sake of clearness, I have made no mention of the physical self. Physical strength, however, is absolutely necessary to success in certain walks in life, as, for instance, in politics and the profession of arms. Many an individual has had within him the germ of a great politician, but has not possessed the physical strength to give proper effect to his genius. The same is also true of the warrior ; one recalls at once the kindly Wolfe.* Physical weakness, and, indeed, continued ill-health, are consistent with fame in certain departments of activity, as in philosophy and the fine arts, for bodily weakness favours a contemplative turn of mind. Many men are shallow-minded in consequence of excessive muscular strength. Their strong animal spirits allow them little time to brood over the problems of life ; the mind goes out to the objects round and about

* Some may not think this a happy example. Speaking of Wolfe, Bancroft says : "He crowded into a few hours actions that would have given lustre to length of life ; and, filling his day with greatness, completed it before its noon." They cannot, I think, take exception to Arthur Henry Hallam as an instance in point. Of him it has been said that he "had always more intellect than he had the physical strength to use."

them, and the reflective faculties remain in abeyance. But if an individual is weak and sickly, the mind is bent in upon itself, and acquires a reflective turn. We often find such individuals doing very well in examinations. They surpass their more vigorous brothers, because mental labour is less effort to them; complete health and strength are apt to revolt against the long hours of physical quiet necessary to laborious mental work, the muscles cry out for exercise, and a strong effort of will—not always forthcoming—is needed to bring the restless mind to a task in which those physically less favoured find actual delight.

CHAPTER VII.

Natural Selection (*continued*)—Its Influence on the Corporeal Side of Man—Disease, a Necessary Evil—Active Operation of Natural Selection in consequence of Instability of the Environment—Perfect Adaptation impossible—Illustrations.

We have now to consider how far natural selection operates on the corporeal side of man, and this question is, from the medical point of view, of even greater importance than how far it influences the mental side, since the great majority of the diseases with which we have to do are diseases of the body.

That natural selection has always been actively at work on primitive man is evidenced by the stationary state of the population. For, since the human race tends to increase in geometric ratio, the population can only be kept at a fixed level by a terrific destruction of life, and such destruction must necessarily, on the whole, be a destruction of the least fit. Warfare has doubtless been the chief check to increase. If we look into the past history of man we see one continued conquest of the weaker. Tribe has conquered tribe, nation, nation ; and often enough such conquest has led to the actual extermination of the conquered. This may arise in a threefold way—(1) by actual violent destruction, (2) through long-continued subsequent oppression, or (3) through the inability of the conquered to adapt themselves to the mode of life of the conquerors ; thus, the coloured races often die out in contact with the white man, not so much from destruction in actual warfare as from an inability to adapt themselves to his ways.

Among savage races the continued warfare has doubtless, on the whole, led to a survival of the corporeally fittest, although sagacity has certainly played a not inconsiderable part in the result. Among the civilized, however, victory rather belongs to

the best disciplined, the best equipped, the most skilfully commanded troops. Since the introduction of firearms, bodily strength and activity play far less part in the result than formerly. Modern warfare, moreover, does not lead to the survival of the fittest, but rather to a destruction of them, since the best physical types are chosen for soldiers, bodily weakness exempting from service.

Infanticide is also largely practised by primitive man. This and warfare have doubtless been the chief checks to his increase. But no doubt disease plays some part also.

And here let it be observed that disease is a necessary evil. Let no man lay to himself the flattering unction that any portion of the animal kingdom can ever be wholly free from disease. This would be impossible under any theoretical system of living which he might devise. We have good reason to believe that pathological variations must ever and anon occur under the most favourable conditions which can be commanded—*i.e.*, an individual may vary in an unfortunate direction, independently of any distinctly pathogenic E on the part of his parents. He may, for instance, vary in such wise that under an averagely hygienic E he will develop tubercle, rheumatism, or other disease; and such unhappy variation, does not, as I have already insisted, necessarily imply a lack of bodily vigour, since, in the case of many of the "germ" diseases, an individual may in all respects be healthy save in his ability to resist the attack of some specific germ.

But apart from such subtle tissue-variations, which render the organism apt to take on pathological change under E's which, to the community at large, are normal, pathological variations which are quite obvious and palpable not infrequently occur. I allude to such cases as hydrocephalus, idiocy, and monstrosity. Children thus afflicted may be born to perfectly healthy parents. No doubt, in some at least of these cases, there is a bad family history; and in others the mother may have been exposed, during gestation, to some form of mal-E, which, with due care, might have been avoided. Nevertheless, it may with certainty be asserted that such abnormal beings must inevitably occur from time to time, even although the parents be selected after

the most approved fashion, and the mother be most carefully sheltered, during the period of gestation, from every possible form of improper influence. Wherefore, I am compelled to confute the assertion of Mr. Lawson Tait—namely, that disease did not exist in wild ancestral man, but first crept in upon him with the advent of civilization.

The belief that disease results solely from the abuse of natural laws has been held by many. John Hunter, amongst others, taught this view. C. B. Sutton, after speaking about the "easy" working of the body, observes: "But we, in our ignorance, hinder the working, and bring about uneasiness, disease, incapacity—and that is the origin of pain." If the writer here means that ignorance is the sole and essential origin of pain, his statement can only be deemed correct in a limited sense. Pain, undoubtedly, often results from ignorance—in a sense, indeed, it always does—since we might, with supreme knowledge, prevent it. But in this sense an earthquake is equally the result of "ignorance." Also, the pain suffered by the lower animals. But using the term in the limited sense which the author is evidently attaching to it, ignorance cannot be said to be the origin of pain.

It is necessary to bear in mind that *the capacity for pain is a physiological attribute*: without it no sentient being —at all events, no such sentient being as a vertebrate animal — could exist. I speak not of the invertebrata, since of their capacities for sensation we know little or nothing. I say the capacity for pain is physiological; for if an individual were not apprised of an injurious agent by the pain which it causes, he would suffer something more serious than pain—total destruction. Although pain in certain instances serves no beneficial purpose, as in cancer, I cannot, therefore, doubt that it is in the main a physiological capacity; and I protest against our speaking of it as a very unpleasant and disagreeable result of ignorance, when it is a highly beneficial and essentially physiological capacity, which affords us very real and effective knowledge; for without it we should not in many instances *know* of the evil residing in the pain-producing object. There can be no doubt that the

capacity for pain, like every other useful attribute, has slowly and laboriously evolved by natural selection.

The notion that disease is solely due to ignorance or wilful misconduct is, therefore, erroneous. No doubt, civilization has multiplied the forms of disease, and vastly increased its proportion, but a proper application of biological laws enables us to assert, *à priori*, that disease must always have existed, apart from the actual observation of facts pointing in the same direction.*

From the above observations, it follows that, even supposing the E to be the most stable possible, varying but little (I say "but little," for we have seen that actual equality of E is not possible for any two individuals) from generation to generation, the principle of natural variation must be ever at work, weeding out a number of unlucky variations, and thus maintaining the proper level of adaptation.

It is quite impossible, even in savage communities, for the E to be perfectly stable from generation to generation. It could not be from the geological fact, if from no other cause, that a ceaseless change is going on in the outer world. Not only is it the detail of the E that is different for individuals born at the same epoch; but far greater and grander differences are caused by the long lapse of time. Thus, in addition to marked astronomical differences, the geological state of the earth is undergoing steady change, and these geological changes entail meteorological changes also. Wherefore, as Herbert Spencer observes, "throughout all time there has been an exposure of organisms to endless successions of modifying causes." †

As an example of changes in the E dependent upon the natural physical processes taking place upon the earth, let us suppose a savage tribe to inhabit a tract of country where subsidence is going on—in the neighbourhood of a large lake or a river-bed, it may be. A portion of the dry land thus becomes gradually converted into a miasmatic swamp. A marked change will thus have been gradually taking place in the E of this savage tribe, and, *pari passu*, the process of adaptation to

* See Lawson Tait, *Dublin Quarterly Journal of Med. Science*, Feb. 1874.

† Spencer's "Biology," ch. ix.

this altering E will proceed. The ultimate result will depend upon whether or not the E is a necessarily fatal one—*i.e.*, altogether incompatible with human life; for if so, the process of natural selection cannot be said to take place, the E leading to the gradual extinction of the race. If, however, the changing E be not necessarily fatal, the process of adaptation will be set on foot. Some members of the community will probably be very susceptible to the miasmatic fever, others less so, while others again may be entirely proof against its evil influence. Such a community would afford an example of a number of individuals varying in their power of withstanding the evil effects of a particular E, independently of a previous mal-E, and independently of general physical weakness, for, as already observed, we have no right to suppose that the capacity to resist the evil effects of a miasmatic poison is in direct proportion to the general bodily vigour of the individual.

Now, what will be the inevitable result of this process? There will be a weeding-out of those least capable of withstanding the noxious E, and thus in course of time a race may evolve perfectly adapted to this particular E. It is, indeed, well known that certain tribes thrive in ague-stricken districts which to surrounding tribes are most deadly; and this immunity has doubtless been acquired by a survival, during long ages past, of such as, quite independently, it may be, of any extraordinary physical vigour, happen to vary in the right direction.

There are, however, other causes of unstable E than those due to geographical change. As man has struggled from a barbaric to a civilized state, there has been an alteration in his E. But the chief cause of the instability of the E among civilized peoples arises from the division of labour; for, inasmuch as each calling has its special E,* it follows that, unless generation after generation of the same family pursue the same occupation, the E of successive generations will be different. Hence the process of adaptation to these different E's, by a survival of the fittest and by "direct equilibration" during successive generations, will be interfered with, adaptation being for the most part personal and nothing more—that

* *Vide* Chapter V. Part I.

is to say, the individual will tend by a direct action of the E upon him to become adapted to it, but seeing that, in many instances, several generations of the same family do not follow the same occupation, there can be no racial adaptation.

Now many of the occupations which the social division of labour has called into existence are necessarily harmful, and cannot be rendered harmless by the most careful State control. So potent for evil, indeed, are certain occupations, and so diverse the forms of pathogenesis belonging to them (for each particular occupation has its own particular set of evils attaching to it), that it would require several large volumes to adequately describe what might be well termed "the occupation diseases."

Nevertheless, in spite of the injurious effects of many occupations, adaptation to some of them is at least theoretically possible. Unfortunately, the E is but too often "necessarily fatal," if not to the first, at all events to the second or third generation living under it. Knife-grinding affords a familiar instance. In others, more or less perfect adaptation by natural selection and direct equilibration may be said to occur; but in order that this may take place, it is necessary for several generations of the same family to follow the same occupation. We do not, however, find this occurring on any large scale. How, then, is it possible that a perfect adaptation to these manifold E's should take place? It is, nevertheless, probable that the community at large becomes, by natural selection, better adapted to the average artificial E; or, if not much better adapted, we must at all events acknowledge that the standard of adaptation is thus maintained at a certain mean (=racial) level.

These observations have a very wide application; but it will be sufficient for our purpose to take a few simple illustrations.

First, let us take the case of a publican. Now, his E is probably of the necessarily fatal order; for if he does not himself succumb to it, the second, third, or fourth generation from him living under it almost certainly will. Nevertheless, a perfect "class" adaptation (meaning, in this case, the "class of publicans") to such an E is theoretically possible by a survival of the fittest. Direct equilibration here would play no part,

for the continued soaking of the tissues with alcohol does not the better enable them to withstand its evil effects. In such a case, therefore, the adaptation would be by indirect equilibration, and it would further be a mental adaptation: there would be a survival. namely, of those capable of resisting the temptation. It is impossible for any class to become corporeally adapted to an unlimited indulgence in alcohol.

Again, let us take the case of the brain worker, leading a life of muscular inactivity.

Out of many individuals devoting their lives to mental work, several will undoubtedly succumb to the E which it entails. If an individual, for instance, have a strong muscular development, and if, as not unfrequently happens, his brain work entails a life of muscular inactivity, such inactivity may lead to serious health disturbance — it may, indeed, indirectly cause death. Such a person should on no account be suffered to remain inactive, for his muscular development is a clear indication that he comes of a stock which for numerous generations has been accustomed to a vast amount of bodily activity, and his entire corporeal and mental being has become organized with a view to such activity. An active E is normal to such an individual, an inactive one, *abnormal*. Doubtless, a considerable degree of personal adaptation may occur, but it can never take place to the fullest extent in the case of a very actively constituted individual. People thus circumstanced will tell us how strongly their instincts urge them to exercise, and that they never feel well when they are unable to indulge in it daily.

Many individuals, however, and such may be quite healthy, are of more slender muscular build. These probably come of a stock unaccustomed for many generations to great muscular activity. I do not, of course, allude to such as are muscularly weak through a general depravity of health and physique. A typical "cockney," for instance, may be descended from very muscular, country-born grandparents, and yet possess a very feeble muscular system, but this muscular inadequacy will be due to a universal physical depravity, consequent upon the unfavourable conditions under which he has grown up. Of such I am not now speaking, but rather of those who, while they

are healthy in all respects, are of delicate muscular build. Individuals thus constituted may enjoy good health though they lead a life of comparative muscular inactivity, and this often happens in the case of active brain workers.

It is possible that perfect adaptation to a muscularly inactive mode of life might in the course of time take place—always supposing the individual to lead in every other respect a perfectly healthy life, the change being wrought by a summation of personal adaptations and a survival of the fittest, that is, by both direct and indirect equilibration. An excess of motor activity is not an inevitable concomitant of life, for some animal organisms are actually stationary. It is true that great muscular activity characterizes the vast majority of animals, since in the struggle for food the muscular system is kept in constant use, and, indeed, its very evolution arises out of this struggle; but there is no reason why, if no longer needed for active work, it should not dwindle to very scanty proportions without injury to health, mental vigour, and longevity, the whole organism gradually adapting itself to the new mode of life. Thus there might evolve a mere "walking brain," so to speak. The physiologist may cry out against this argument, urging that a certain measure of muscular activity is a physiological necessity, that without it the various glandular organs—as, for instance, the skin and liver—would fail in their duty, and that such an inactive mode of life must inevitably lead to degeneration and extinction,* I see, however, no reason why the whole of the body should not become adapted to the new order of things, provided the E remained stable from generation to generation.

But the E not being thus stable from generation to generation, such an adaptation will probably never take place, and it is very unlikely that many successive generations will ever lead a highly inactive mode of life; moreover, the procreative power of man would appear, according to Herbert Spencer, to diminish with the advance of mental evolution. These considerations, however, do not negative the fact that

* Kingsley, in his "Water Babies," makes the over-developed heads collapse like "watery turnips!"

individuals differ markedly as to the degree of muscular exercise requisite to maintain them in health.

Let it not be supposed from these remarks that I would for one moment counsel a life of muscular inactivity. Man in his present state of evolution cannot expect to be a walking brain. I have merely wished to point out that a considerable degree of adaptation to a life of comparative muscular inactivity might occur. Such adaptation can, however, only take place in rare instances. It therefore follows that a fair amount of muscular exercise is absolutely necessary to health and to the full enjoyment of life. An enormous amount of suffering might be averted by due indulgence in it.

In regard to the quantity of muscular exercise needful to health, each indivividual, as my remarks have already implied, is a law in himself: some can lead more or less inactive lives with impunity, nay, even with distinct advantage, while others suffer much ill-health if circumstances do not permit a large amount of bodily exercise. Over and over again I have observed this among young men, chiefly of the muscular kind, while working up for examination. The higher nerve centres are then being spurred on to a great effort, while the muscular system is kept in a state of almost complete rest. Under these circumstances it not unfrequently happens that a mental gloom, among other evil effects, comes over the individual; but this, and, indeed, all the bad symptoms, are speedily removed by a brisk walk across country. I have also frequently heard young men with a tendency to uratic deposits observe that a good walk would clear the urine and remove many unpleasant symptoms.

It must not be supposed, on the other hand, that excess of muscular exercise, even under the most favourable conditions, as those of the agriculturalist, is an unmixed blessing. Man was never intended to work like a horse; his frame is not constructed with a view to strength primarily. He has evolved under conditions of moderate muscular exercise, and such may be said to be the normal condition for the healthy man. Other things being equal—constitution, food, hygienic conditions—the hard-working farm labourer does not live longer than the leisurely-working country squire. Doubtless,

the average life of the labourer is longer than that of his more fortunate (?) brother, but there are other influences at work to explain this.

That laborious muscular exercise is not essential to the health of man is proved by studying the families of our aristocracy. There is no proof that lack of laborious exercise has reduced their standard of health. The deterioration in type which often occurs among such families can be explained in other ways. Be it remembered that it is only during a comparatively recent period in man's history that the muscular system has been subjected to continued, laborious work. Many primitive tribes, it is true, are accustomed to long-sustained muscular exercise, as in hunting and fighting, but this is very different to continuous heavy labour, which has only fallen to the lot of man within comparatively recent times. Hard work not being the original lot of man, few men take to it naturally, easily, and willingly. Men work through necessity, and only by practice does what was once difficult become easy. But in civilized communities there is always a large number of idle vagrants who will not work. Such are reversions, for they exhibit that disinclination to muscular work which belonged to their primitive ancestors. What is true of muscular, is also true of intellectual, work. Although many children take naturally to their books, the majority do not: they exhibit the mental tendencies of their remote ancestors, their chief mental delight being derived from a direct contact with nature, such as is obtained by roving about the fields and woods.

I have taken two instances—viz., that of the publican, and that of the brain-worker leading an inactive mode of life—in order to illustrate my statement that more or less perfect adaptation to many of the pathogenic E's which obtain in a civilized community would take place, if several successive generations were placed under the same E. Many other examples might be given, and the reader has ample opportunity of applying this principle for himself, and of testing its applicability.

CHAPTER VIII.

Natural Selection (*continued*)—Adaptation to Micro-organisms—The Instability of these latter interferes with the Process of Adaptation.

INSTABILITY of E has been a great check to perfect adaptation. Granting stability of E, adaptation to it must sooner or later occur, provided only that it be not necessarily fatal.

Such being the case, the question may be asked, How is it that mankind has not become perfectly adapted to the poisons of scarlatina, measles, typhoid, and so forth? To this it might be replied that these are "necessarily fatal" forms of E, and that man has only survived them because, fortunately, they are limited in quantity; but this is not the correct explanation. The failure of adaptation to these poisons lies in their instability. We have seen that adaptation to the specific mal-E constituted by the ague poison is possible. In this case the poison is probably fairly constant from one generation of man to another. In the case of the specific fevers the poisons are essentially fickle, as is very simply proved by the fact that each epidemic has its own special characters. Nor should this fickleness, or "variability," surprise us, seeing that the disease-causing agent consists of a living organism, and remembering that all organisms must necessarily vary from generation to generation. We cannot exempt the countless varieties of unicellular organisms from this universal biological law. In a very short space of time they pass through many thousands of generations; hence, during each successive generation of man, they have ample opportunity of becoming modified.

But despite their instability, a very active adaptation to these specific E's *does* take place among men. This adaptation is in no way personal, but results from the survival of the fittest, viz., the survival of those best able to resist their harmful effects. It is well known that the introduction of

a fresh contagious disease into a country is wont to play great havoc. This has been amply proved in the case of scarlatina, small-pox, and measles. It must be fresh in the memory of many how the North Canadian voyageurs were destroyed almost to a man by small-pox soon after their landing at Gravesend, on their return from the Nile expedition. Some of them, it is true, had been vaccinated, but their susceptibility was probably far greater than that of the average Englishman. Darwin observes that on the island of St. Helena scarlatina is dreaded as a plague.* Now it is possible that communities may from the first differ from one another in their susceptibility to various contagia, irrespective of any process of adaptation—before, namely, any adaptation by a survival of the fittest could have occurred; but it is none the less certain that the difference in respect of resisting power to a particular virus between communities which have for a long time been exposed to its influence, and such as never have been exposed to it at all, is chiefly, if not entirely, due to such process.

It may be thought that I am exaggerating the part played by natural selection in respect of specific contagia. A little thought will, I think, show that this is not the case. Individuals differ prodigiously in the resisting power which they offer to the various contagia, wherefore natural selection—the survival of those best able to resist these poisons—must inevitably occur. Some families there are who show a great susceptibility to measles; others are, in like manner, particularly susceptible to scarlatina; others, again, to typhoid, contracting the disorder readily and in the most virulent form. Our present Royal family, for instance, displays a peculiar susceptibility to the typhoidal and allied poisons. The individuals thus unfortunately varying are being continually weeded out with an unsparing hand, albeit they may, in all other regards, be perfectly healthy; and when it is remembered that, of the many who are exposed to these several poisons before the procreative period, such only are suffered to leave offspring as can successfully battle against them, it is clear that the incapacity to withstand the poison is not, in such cases, transmitted. Surely this active elimination

* "Voyage of *Beagle*," p. 434.

must be tending towards a complete adaptation, for how countless is the number which are yearly thus destroyed! And that such a complete adaptation would actually occur, I doubt not, were the virus constant in its properties during several generations of men. Since it is not, perfect adaptation is impossible; but there is a continual struggle towards it, and in this way a certain level of adaptation is maintained.

Next to instability of E, the growth of hygienic science is the most important check to the process. Take the case of typhoid fever: a number of individuals congregate, the typhoid germ comes into being, and disease results.* Forthwith the process of adaptation is set on foot, but the reasoning power of man at once steps in to check its progress. He searches out the cause of typhoid, and directs his efforts to its destruction. A perfect adaptation to a typhoidal E, even were it possible, would involve a terrible sacrifice of life, so that man wisely determines to control the E; that is to say, he adapts the E to himself, instead of allowing himself, or rather his race, to be adapted to the E during the long course of ages.

There is nothing absurd in the supposition that man could ultimately become adapted to a typhoidal E, provided only its fixity could be guaranteed. The yellow fever, so fatal to the white man, rarely or never attacks coloured races. This poison, therefore, does not constitute a necessarily fatal form of E. Now I do not contend that the coloured races have adapted themselves to the yellow fever virus by a process of natural selection. Whether or not this is so, I do not pretend to say: so far as I know, there is no evidence in favour of it. I merely wish to emphasize the fact that a poison, probably generated by the

* I confess I am one of those who believe in the *de novo* origin of specific fevers. It may be regarded as proved that these fevers are due to "germs," but many hold the theory of spontaneous generation to be untenable. Supposing, then, spontaneous generation never to occur, and the specific fevers to be due to germs, how can we account for their *de novo* origin? In a very simple way. We have only to suppose the *de novo* assumption by non-pathogenic germs of pathogenic properties, such assumption resulting from peculiarities of germ E; in which case, looking on spontaneous generation as an impossibility (which I for one am far from doing, for at the most we can but prove that this never occurs in a test tube), and on the specific fevers as due to specific germs, we can yet readily account for their *de novo* origin. *Vide* "The Evolution of Morbid Germs:" K. W. Millican.

crowding of coloured men, has no effect upon them, while to the white man it is terribly fatal. Did we not know the black to be proof against yellow fever, we should doubtless assert with confidence that the poison of this fever was one which must inevitably provoke disease in all, but since such is the case, what justification have we for asserting off-hand that the typhoidal poison constitutes a necessarily fatal form of E, and that adaptation to it is impossible, provided its stability were guaranteed?

The aim of hygiene being to destroy, as far as may be, these specific zymotic E's in the interests of humanity, we may ask—Does it not, by checking adaptation, in some measure defeat its own ends? The answer is decidedly—*Yes.* But the good effects far outweigh the evil. Instance the case of scarlatina. The poison is, as it were, hunted down by a system of isolation and disinfection. If this system be carried out with great care from year to year, the number of cases of scarlatina will tend to diminish; for, if fewer be exposed to the poison, fewer can contract the fever, and in this way it might be possible to exterminate the parasite altogether. The effect of this would be meanwhile to increase the severity of the cases which do occur—always supposing the virus to remain the same—for the process of elimination will be interfered with, and the standard of adaptation consequently lowered. Wherefore the hygienist has two powerful arguments to justify his course. First, there is the possibility of completely hunting down the poison (and there is no doubt that with great care this could be done); secondly, the poison being the product of living organisms, and therefore essentially variable in character, it necessarily constitutes a great check to adaptation by natural variation.*

* Mr. Parker (*British Medical Journal*, Nov. 5, 1878, Jan. 7, 1887) does not regard the system of isolating cases of scarlatina as an unmixed blessing, for he contends that the adult is quite as liable to contract the disease as the child, and that the disease is more serious in adult life than in early youth. Facts, however, speak strongly against both these views. Murchinson long ago asserted that the adult is both less liable to contract the disease, and more likely to have it in a mild degree, and the Registrar-General's report for the past year bears out these statements. Mr. Parker further contends that "strict isolation will gradually increase the number of persons unprotected by a previous attack, and, therefore, the number of persons liable to be attacked during any given epidemic." This, he tells us, is "his main contention." No one would con-

Enough has now been said to show that a continual adaptation to those morbific agencies which are not necessarily fatal is taking place, and that as regards contagia, the success varies in different instances. Perfect success has apparently been achieved in the case of the ague poison (or, perhaps, it would be more correct to say, certain varieties of the ague poison, for there are many different kinds), but only very imperfect adaptation to the ordinary zymotic poisons has been effected. Yet I doubt not that man has by natural selection become adapted to many microbes which in the past were fraught with the greatest evil for him.

Many zymotic diseases which, as we know from history, once wrought great havoc, have completely vanished, but how many more must have existed of which history is silent? We may be sure that man suffered from zymotic disease long before he took on his present shape, far down in the genealogical tree.

How, then, are we to explain the disappearance of these diseases? Many of them have doubtless vanished with the E which brought them into being. The great epidemics of the Middle Ages arose out of grossly impure hygienic conditions, and the pathogenic germs causing them disappeared with the hygienic improvement. It may be that the germs died right out; or we may suppose them to have lost their pathogenecy through natural variation, for it is well known that unicellular organisms, in common with the more complex forms of life, are capable of being modified by a modification of their E. It is highly probable, however, that perfect adaptation to them has taken place in the past by natural selection. Let it ever be borne in mind that man, like all other living things, has gradually evolved by a continued adaptation to his E. He has been gradually moulded so as to fit more or

fute it, but this is no argument against isolation; the number of individuals attacked "during any given epidemic" might be greater, but the proportion of individuals attacked during a given long period of time, would not be nearly so great, although the process of natural selection would be interfered with, and the number of the *susceptible* thus increased, but no mention was made of the influence of natural selection during the discussion of this subject in the *British Medical Journal*. A further point was left out of consideration in the discussion. If the disease is to kill or cripple its victim, is it not better that it should do so as late in life as possible? If a man dies of scarlatina at forty instead of at three, he has gained thirty-seven years of a possibly healthy life.

less accurately, if one may so put it, into his E; and at what prodigious sacrifice of life only those can realize who have examined thoroughly the doctrine of evolution in its many ramifications. And I doubt not but that one of man's most malignant foes has been the one-celled organism, and that his struggle against it has been severe in the extreme. One would not, *à priori*, suppose that any unicellular organism was necessarily fatal to a multicellular being, for is not the basis of life one and the same for all—viz., protoplasm? No fact of biology is more remarkable than that one form of protoplasm should be capable of exerting a poisonous effect on another. This effect is brought about by the emission of certain poisonous matters. In pyæmia, for instance, the evil results from chemical matter given out by certain micro-organisms. These chemical products are powerless to harm the micro-organisms emitting them, but are, nevertheless, capable of destroying many multicellular organisms—man among others. Now, the fact that a certain chemical substance is harmless to one form of protoplasm, but capable of producing disease in another, is suggestive, at least, that this latter form might also become capable, by adaptation, of withstanding its evil effect; and this suggestion is rendered all the more probable by the fact that different species of animals differ most extraordinarily in their manner of responding to different micro-organisms, for what will produce rapid death in one will be quite harmless as regards another: nay, more than this, a like difference may, as we have already seen, be observed among the various members of the same species.

Now, all these facts tend to show that adaptation to almost every variety of pathogenic micro-organism would be possible, provided the latter were fixed in properly. The variability in unicellular organisms has tended to prevent this, and, but for this variability, it seems to me highly probable that perfect adaptation to all forms of pathogenic micro-organisms would long ago have occurred. Even as it is, this adaptation has probably taken place to a large extent, and who knows but that we may be living in the midst of an infinite variety of micro-organisms which at one time were capable of striking our ancestors (near or remote) with the most fearful

diseases, but which now, by a gradual process of adaptation on the part of our forefathers, have become powerless to do harm?

A curious fact which I have recently learned tends in some measure to confirm these views. According to the Rev. J. Williams, the first intercourse between natives and Europeans "is universally attended with the introduction of fever, dysentery, or some other disease, which carries off numbers of the people. . . . Most of the diseases," he continues, "which have raged in —— during my residence there have been introduced by ships, and what renders this fact remarkable is that there might be no appearance of disease among the crew of the ship which conveyed this destructive importation."* Darwin also observes that "the first meeting of distinct and separate peoples generates disease." Now these facts show that each separate community is exposed to some specific form, or forms, of E, which, although perfectly innocuous to itself, may be distinctly pathogenic to others. What is the exact nature of the pathogenic E or E's in each case it is impossible to say, but it is probable that the virus is not that of any well-known "specific" fever. The important fact to remember is that each community is perfectly adapted to its particular virus, or varieties of virus. This adaptation may be the result of natural selection continued through long ages. Nevertheless there is evidence that the mere congregation of individuals may beget a poison to which gradual personal adaptation may occur.

In the Black Assizes, for instance, the prisoners brought to trial from the putrid gaols communicated a fatal form of fever to the judges sitting in court, *the prisoners themselves being quite free from any trace of fever*. Now, seeing that the latter must have swarmed with the morbid germs, it seems probable that they had gradually become adapted to the mal-E of the prisons, just as a mouse can in some measure adapt itself to an atmosphere exhausted by respiration; for if one of these animals be placed in a vessel till the air has been in this way greatly exhausted, and a second one be then introduced, the latter will be the first to succumb, showing that a certain amount of adaptation has occurred in the survivor. The same line of argument might be applied to the prisoners of the Black Assizes.

* Quoted by Sir William Aitkin: "Evolution in Pathology."

Another construction, however, may be put upon the case; it is possible that the unfortunate wretches who were brought up for trial were but a surviving few, the greater number of the prisoners having succumbed to the fever, and, supposing this to be the correct interpretation, we have in it a good example of natural selection—the survival of those who were fittest as regards a specific mal-E.

The following is a very similar instance: "In the early part of the reign of George III., a prisoner who had been confined in a dungeon was taken in a coach with four constables before a magistrate, and, although the man himself was not ill, the four constables died from a short putrid fever; but the contagion extended to no others." From these facts "it would appear as if the effluvium of one set of men, shut up for some time together, were poisonous when inhaled by others; and possibly more so, if the men be of different race."* In this case also two explanations may be offered. We may suppose the prisoner to have gradually adapted himself to the dungeon atmosphere, or, again, that he was one of a very few who from the first were proof against it.

A consideration of the different effects of the same contagion on the human organism brings one important fact into prominence—namely, that normality both as regards S and E is only a relative expression. If an individual can live healthily in any particular E, he may be regarded as normal to it, and it to him When, in short, there is perfect adaptation between S and E, each is normal as regards the other. A tribe of savages living healthily in an ague-haunted district might, with some show of truth, exclaim: "You white men are abnormal, for you sicken and die in an E which is perfectly normal." With equal justice the white man might retort, "*No;* your E is abnormal, and therefore I, who am perfectly normal, sicken when exposed to it." Each statement would be correct. To the savage tribe the ague-stricken E is perfectly normal, but to the white man intensely abnormal.†

* Darwin, quoted by Sir William Aitkin: "Evolution in Pathology."

† This question of Abnormality will be considered in Part III.

CHAPTER IX.

Natural Selection (*continued*)—The Necessarily-fatal Environment.

When treating of natural selection it was found advisable to divide the different varieties of E into two classes—namely, those to which the human organism is adaptable, and those to which it is not. The latter class was spoken of as the class of "necessarily fatal" E's, inasmuch as such E's necessarily lead to destruction, and it is this class that we may now with advantage consider at greater length. As regards many forms of E, such as poisons and violence, their necessary fatality is at once obvious; but besides these there are others, which, although not necessarily fatal to the individual in the sense of causing more or less immediate death, are yet necessarily injurious to him, and "necessarily fatal" to racial life, or, perhaps I ought to say, family life. By this I mean that, if successive generations of the same family be reared amid such E's, a total extinction of the family will sooner or later follow.

Now the number of these forms of necessarily fatal E is exceedingly great in a civilized community, far greater indeed than mere casual observation would lead us to think. We may lay down the broad rule that (other things being equal) the E of any given individual is healthy in proportion as he lives in the open air, and exercises therein; and contrariwise, the E is unhealthy in proportion as his life is spent in confinement and muscular inactivity. Civilization entails much indoor confinement, and herein lies, I believe, its chief evil. It is probable that all occupations which necessitate prolonged confinement from a tender age upwards, whether in town or country, are necessarily fatal, and certainly all those are which prevent the enjoyment of *fresh* air and proper bodily exercise from time to time. But, apart from the injurious effects directly

traceable to confinement, pure and simple, and which are experienced, even though every hygienic precaution be taken to render the air breathed pure and healthy, there are many occupations, both indoor and out, which necessitate the breathing-in of irritating particles, and there are a host of others which injure in ways innumerable. Such E's are probably all necessarily fatal.

This may at first sight appear to be a gross exaggeration; we must, however, bear in mind that there are several circumstances tending to mitigate and to obscure the fatal results. In the first place the injurious occupation is in many instances not followed until the individual has nearly arrived at, or has actually reached, maturity; and, some little time being required for the E to work its injurious effect, he may meanwhile rear healthy offspring, more especially if he live in the country, where the children can have abundant outdoor exercise. Seeing that legislation cannot render all occupations strictly healthy, we ought at least to see to it that as far as possible boys and girls be not allowed to follow injurious occupations. It is during the growing period of life that a mal-E works its greatest evil, for it then interferes with proper body-growth, and leads to rapid physical deterioration. If possible, then, we should prevent a young growing individual from following an injurious calling. Such a prohibition is, however, often impracticable, for most of these very occupations require early apprenticeship, sometimes, indeed, commencing in extreme youth.

A second circumstance tending to prevent this family extinction is the very obvious one that all the members of the same family rarely follow the same injurious occupation for several successive generations, and if only a few of the children engage in healthy outdoor pursuits, the family may thus continue its existence.

In large towns, however, most of the children, although not often all following the same occupation, nevertheless very generally follow some other injurious calling, or are from the beginning of life brought up under unfavourable conditions; wherefore, as we shall presently see, a large town constitutes in itself a necessarily fatal form of E. But, leaving

for the moment out of account the injurious effects of large towns, we may affirm, with perfect assurance, that if two or three generations engage in indoor occupations from a tender age upwards, or follow such an occupation as stone-grinding, which necessitates the breathing of an irritating atmosphere, or, indeed, any occupation which exerts a markedly injurious effect upon the body, family extinction will inevitably occur. The gaps thus created are, however, eagerly filled up in the fierce struggle for existence, and thus it is that, while extinction of individual families is ever and again occurring, each class maintains its integrity, just as does a living organism: fresh material is ever at hand to take the place of the cast-off, worn-out products; and it matters not to the social organism whence it shall be recruited—whether it shall be from persons whose parents formed part of it or not.

I have not attempted to enumerate the many different kinds of occupation which entail upon the luckless individuals following them a necessarily fatal E, for this would occupy too much space; but it is well that we should be alive to their great number, and I therefore venture to recommend a serious study of this question to such of my readers as have not gone into it thoroughly.

The mal-E's of which I have hitherto spoken, are such as are entailed by bread-winning occupations; but over and above these there are many to which the individual voluntarily exposes himself for the sake of pleasure, such as intemperance in eating and drinking. These belong to the necessarily fatal class of E's, for they must lead to family extinction if several generations of the same family indulge in them from youth upwards.

Let us now briefly turn our attention to the E obtaining in large cities as distinguished from that belonging to the country. There is no doubt that the E obtaining in the central parts of all large towns is necessarily fatal, owing to the lack of sunlight and fresh air. As Mr. Cantlie observes, fresh country air has not blown over the central parts of London for fifty, or it may be even a hundred, years. He attributes the evil results to the lack of ozone, which is entirely absent from London air; and he adds that sun-burning never

occurs in London, remarking that an omnibus driver never gets brown; "he gets red, and you can see the cause of the redness to be dilated vessels in the skin of his face." But, although bronzing does not probably take place so readily in London as in the country, even though the exposure to the sun be the same in each case, I am nevertheless convinced that it does actually occur. However, setting aside this question as to the special effect of the absence of ozone, the fact remains that residence in central London rapidly tends to deterioration, and finally to family extinction. Mr. Cantlie has been unable to find an individual whose ancestors from the grandparents downwards were born and bred in London. The following two cases are the nearest approach to such an ancestry: "The first is that of a 'man with a Somersetshire grandfather,' whose folks had lived in London, commencing from the grandparents. Height, 5ft. 1in.; age, 21; chest measurement, 28in. His head measured around above the eyebrows is 19in. (nearly three inches below the average); measured across from tip of ear to tip of ear, 11in. ($1\frac{1}{2}$in. below the average). His aspect is pale, waxy; he is very narrow between the eyes, and with a decided squint; solemnity intense." The second case is that of a "'man with an Irish grandmother,' but the others of whose predecessors have lived rigidly in London from the grandparents downwards. Height, 5ft. 3in.; age, 19; chest measurement, 29in. His head measures 20in. round (2in. below the average). His face is mottled, pale, and pimpled. He squints rather badly. His jaws are misshapen; he cannot bring his front teeth within half an inch of each other; his upper jaw is pointed, and falls within the arch of the lower; his teeth spiculated, and must be well-nigh useless to him. Solemnity great. . . . . These specimens I have come across, as I say, after much inquiry. I have never come across the children of any such, and I believe it is not likely I ever shall. Nature steps in and denies the continuance of such, and weakness of brain power gives such a being but little chance in this struggling world." *

I do not altogether agree with this author in regarding deficiency of ozone as a potent cause of degeneration. The Jewish race

* "Degeneration amongst Londoners," by James Cantlie.

has for thousands of years lived in towns, large and small, and there must be many Jews who can trace their London ancestry through several generations, but these are of the comparatively wealthy class. The chief cause of degeneration I believe to be close confinement in rooms. Children of the well-to-do, living as they do about the large squares and parks, may grow up well and strong (although it is doubtful whether even they attain the same vigour which a country bringing-up would have secured); and, moreover, we must remember that many such children are educated in the country, and spend several weeks every year at the seaside. But the children of the poorer classes in London are brought up under conditions which inevitably lead to marked and rapid degeneration. Probably all of them have rickets. None of them can get the pure air which the laws of health demand, for they are confined during almost the entire period of their babyhood in dark and ill-ventilated rooms. When, however, a Londoner leads an out-door life, considerable physical strength may be attained. Many instances might be cited in proof of this: Jem Smith, the champion English prizefighter, was born and brought up in the East End of London (a considerable period of his youth was spent in an open timber-yard, where he had the advantages of open air and muscular exercise), and one may observe in London-born navvies, too, very good development of body. Wherefore I attribute the physical degeneracy of Londoners to the bringing-up of the children in close, ill-lighted rooms, and to their subsequently following employments which entail prolonged confinement indoors. During the whole period of his life, indeed, the true cockney—namely, the individual who is London-born and strictly London-bred, gets neither that amount of exercise nor that purity of atmosphere which the laws of health demand. He is placed under an environment totally different from that in which the human race has evolved; and it therefore follows that the vast majority of the true Londoners—I allude not to the inhabitants of the suburban districts nor to the well-to-do, who can battle more or less successfully against the unfavourable conditions—have the seal of fate stamped upon them: they can never leave a remote posterity.

I have little doubt, however, that, even among the well-to-do, continuous and uninterrupted residence in London would sooner or later lead to family extinction. Probably such extinction would not occur until several successive generations had been so brought up—a thing that never happens with these classes. In the case of the lower classes, however, there can be no doubt that the family line practically never passes beyond the third generation of the London-born and -bred.

There can be no better place to observe the degenerating effect of London life than a London Children's Hospital. Here one has the opportunity of watching the mother and her children till the latter reach the age of twelve or thirteen. A very large number of the mothers, though living in London, are country-born, and in such cases we can compare the country-born mother with her London-born children, and can thus discover how much deterioration may be wrought in a single generation. The contrast is, in many instances, positively startling, and it is best observed in the bony conformation of the head; but it is unnecessary to particularize the points of change.

I may here remark that a London out-patient room affords an interesting place of study for the anthropologist, for he can there observe people who have come from all parts of the country. It has surprised me to find how distinctive is the cranial conformation in various districts; for instance, the head of the Essexer is very different from that of the Devonshire or Oxfordshire man or woman. I believe a careful study would enable one to form a very shrewd opinion as to the birth-place of different individuals. I was led to notice this when inquiring into the ancestry of London-born children. I ascertained the ancestry, as far as the grandparents, of over two hundred London-born children while helping Dr. Abercrombie at the Great Ormond Street Hospital; in only two or three instances were the parents and grandparents born and bred in London, and in each of these cases the children were particularly delicate.

In a London Children's Hospital, then, we read the naked truth about degeneration, for we see the process going on from week to week under our very eyes, and this leads one to

ask, What can the London hospitals do for the sickly children brought to them? If they are ill of acute disease, their lives may indeed often be saved, and when suffering from other affections they may be patched up; but at best it is a mere "*patch-up.*" Only a few cases can be taken into hospital; the great majority have to be treated as out-patients. Children are brought dying for want of proper air and food, and the physician is often sick at heart as he feels the futility of for ever prescribing cod-liver oil and iron while the struggle is one against the very conditions of existence, when what is wanted is not physic, but good wholesome food, and sunshine, and the sweet breath of heaven—the eternal requirements of Nature—to substitute drugs for which is a wretched mockery. These can but patch up the ailing little bodies—a poor triumph for a noble art, and yet all that the inevitable deterioration consequent on the conditions under which they grow up leaves possible.

The typical full-grown cockney is in truth a painfully deteriorated type of humanity. Who that has observed a London mob can have failed to be struck by this? I once saw such a mob, some four or five hundred strong, marching, with banner and trumpet, to a "demonstration." They were indeed a blighted band—pale, wizen, stunted; and as they marched along, thinking no doubt that their many troubles arose from unfair legislation, and vaguely dreaming, it may be, that a happier lot would fall to their descendants, I could not but be struck with the irony of Fate, for it was painfully evident that not one of the sad faced crowd would live in a remote posterity. The seal of doom was plainly marked upon them all: a few sickly children perhaps they might rear, but it was clear that sooner or later each family line must ingloriously end.

Healthy, honest country folk come up to the great city to seek their fortune, little knowing how they will be swallowed up by the devouring monster, that their children will not be like them or their fathers before them, but will help to fill the ranks of a diminutive and degenerate race—of a race which is perpetually rushing towards extinction. And yet, if you ask these people whether they like London or the country best, the answer is almost always in favour of the former.

Our giant city affords an example of Social Evolution pushed to the farthest limit yet attained, but at what a cost to individual health! Government is careful to educate the rising generations of Londoners, oblivious of the fact that it is educating a race which is continually travelling towards extinction. Herbert Spencer, with his marvellous power of detecting similarities, has likened a society to an animal organism. London is such an organism: as this process of extinction proceeds among its various family units, a fresh stream of healthy country blood continually pours in to replace them, and thus the great monster is kept alive.

We have seen that the central parts of large towns necessitate an E which is incompatible with the survival of more than two or three generations of the same family, and that the population of such towns is kept up by the continued influx of healthy country-bred people. Some maintain that the same argument applies with equal force to the modern American race—that it, too, is only prevented from extinction by the continued inpouring of fresh European blood. According to this view, the E, as determined by the conditions of American climate and society, is necessarily fatal to Europeans. Be this as it may, there can be no doubt that the American, in certain of the States, is undergoing a profound change, and it is quite clear that this modification is not due to natural selection, but to the action of E upon S, irrespective of any selective process—*i.e.*, by direct equilibrium. It must be remembered the United States are of large extent, and that the E differs very much in different parts. In certain States the immigrated European is undergoing marked deterioration, and in these, I take it, the E is necessarily fatal, so far as the European is concerned; but this is by no means true of all parts of the country; and it would be easy to find many where the inhabitants are strong and vigorous.

I may refer to one other example of necessarily fatal E. It is well known that when the white man takes up his abode in an uncivilized country the aborigines generally become extinct. In certain cases, doubtless, they are actually destroyed by violence or oppression, but it also very often happens that extinction results from the inability of the aborigines to adapt themselves

to a civilized E. This E is, in such instances, by no means one that is hygienically fit in every respect; nevertheless, taking the good with the bad, the white race is capable of thriving in it. Many instances of extermination from this cause might be cited, but it is enough to remind the reader of the rapid extermination of the natives of New Zealand and Australia. Seeing that all men are descendants of one common ancestor, it is a remarkable fact that these people should be incapable of living in an E which is perfectly favourable to the white race. The explanation must be sought for in the fact that the growth of civilization has been gradual, and man has meanwhile been adapting himself to a civilized E.

Dr. Knox has written an interesting and elaborate work * with the object of proving that each race of man is capable of thriving in that particular part of the world alone in which it is found, and, among many instances, he cites the case just alluded to of the modern American people, who, he asserts, would rapidly die out were it not for the abundant influx of fresh European blood. Although I believe this position to be untenable, Dr. Knox's assumption contains, nevertheless, some germ of truth: it emphasizes the facts that every race has become more or less perfectly adapted to its own particular region, and that, when migration to a totally different climate occurs, some time is needed for re-adaptation, and it further prepares us for finding that in certain cases adaptation cannot occur at all. It is probable, for example, that the English people could never become adapted to the Indian climate, for, unless brought up among the "Hills," English children seem quite incapable of growing up healthy in India. Suppose, however, a colony of English people were to gradually migrate, generation after generation, eastward towards the Asiatic continent, and ultimately to arrive in India—then, doubtless, by a gradual process, they would become more or less perfectly adapted to the Indian climate. The process of adaptation would, in fact, be spread over many generations.

* "On the Races of Man."

CHAPTER X.

Natural Selection (*continued*)—The Environment afforded by the Country.

HAVING considered the injurious effects of town life, we may now briefly turn our attention to the E as it obtains in the country.

Here, with the pure air and the open spaces, E stands in very striking contrast to that of the central parts of large towns. So favourable indeed is country life to health that one would scarcely expect to find there any deteriorated types. Nevertheless, we do find such side by side with the best samples of the race. The noblest specimens of men, taking them from the physical point of view, are the outcome of long ancestral country life. The country is, in fact, the great breeding ground for man, as for so many other animals: it is the men born and bred in the country who will be the forefathers of future generations.

How, then, are we to account for the inferior types of physique and for the sickliness which are found often enough in the country?

The good effects of country life are due to the purity of the atmosphere and the abundant opportunity afforded for out-door exercise, for in genuine country life the greater portion of each day is *spent out of doors*, and not in confinement. Pure air and proper exercise are the most important elements of a healthy E. If to these we add proper food and clothing, we have all that is wanted to make it physically complete and perfect, and, given such an E, a healthy race must needs grow up. No doubt, even under a perfect E many individuals would be destroyed by accident, fever, and so forth, but death due to such causes leaves no evil effect upon the race; it, on the contrary, rather tends to its improvement.

The inferior physical types found in the country are due to the fact that all who are born and bred there do not enjoy in perfection the several hygienic requisites just enumerated. In the first place, a large number of country folk are underfed, and this undoubtedly leads to decrease in stature and general physical deterioration, just as an abundant food supply has the opposite effect, as our domesticated animals so well show. Many country folk get little meat, and have to subsist chiefly on vegetable diet. It is doubtful, however, whether an *ample* vegetable diet is injurious, for our remote ape-like ancestors were entirely vegetable feeders. Be this as it may, no one can doubt that the country folk suffer much from lack of sufficient food.

In the second place, although living in the heart of the country, many of the poorer folk enjoy the fresh air in only a very small degree. The men, it is true, spend the greater part of the twenty-four hours in the open, but the women live almost entirely indoors, seldom going farther than a few steps from the house, domestic duties practically compelling them to stay at home during the greater part of their married life. And "home" —sadly misleading word—is often only another name for a badly built, ill-ventilated, overcrowded hovel, where the windows will not open and the doors will not shut, where the sunlight cannot get in and the damp cannot be kept out. I would not for a moment overlook the much that has been done in late years by landlords and others—all honour to them—to bring about improvement in these matters, but there can be no doubt that the wretched insanitary condition of the cottages of the peasantry in the past has largely to answer for the present deterioration of many from among our country population. And these unhealthy conditions are by no means altogether things of the past even yet; there are still many "dark places of the earth" to be found on open hill-side, breezy moorland, sea-washed coast. One particular coast village that I have now in mind bears out this remark painfully. It is not more than a year or two since I noted it. Here was a community living upon the very edge of the Atlantic, and if there was one spot on earth where the air might be expected to be pure and healthy, this was it. Yet I

found the people huddled together in a very nest of abomination, doing, it would seem, their utmost to shut out the fresh sweet breezes.

Nor was it only in the village—and there were only too many like it in the neighbourhood—that there was such a contrast between natural features and the habitations man had made for himself: it was the same in the scattered, outlying cottages with which that part of the country abounds. I went one day to visit a patient who dwelt high up on the slope of a hill a few miles distant from the village. It was late summer, and gorze and heather were in their full glory of gold and purple. Below was the clear, blue water, breaking in white foam upon the rocks, a crisp, invigorating breeze swept up from the sea, the sun was warm and bright—everything suggested life, purity, health. Surely here disease could find no lurking-place? Yet the little rustic cottage whither I was bound, for all its picturesqueness, was a very hot-bed of disease-engendering organisms. In the small dark attic lay a young girl sinking fast under consumption: she was, in fact, already in a typhoid state, and she soon after died. The odour of this little room was overpowering, and no wonder—for a whole family of eight slept in it, and the tiny casement was seldom opened!

The great contrast, so often noticed, between the physique of the two sexes is explained when we remember how much of the women's lives is spent in houses such as these. This contrast is very striking in the particular village in question. The women grow rapidly old and wizen after marriage, and this, doubtless, because they are cooped up all day in dark and foul-smelling rooms, while the men—sturdy, handsome fellows—are busied either upon the sea or by the shore.

Indoor life is, to a very large extent, a necessity with the women, but habit so affects them that in course of time they grow quite indifferent to the confinement, and care no more for fresh air than for the beauties of the surrounding scenery; indeed, in some cases there is an actual aversion to going out. One woman in this village had not stirred from her house for fourteen years, and a few steps would have brought her to the brink of the Atlantic! I may add that, after persistent per-

suasion, I managed to entice this curious soul out of her hole, and had the satisfaction of seeing her brought face to face with the healthy natural surroundings.

These considerations render it very evident that one may live in the country and yet be deprived of that very particular which constitutes the essence of its healthiness—namely, pure air.

CHAPTER XI.

Natural Selection (*continued*)—The Comparative Activity of the Process in Civilized and Primitive Man and in the Lower Animals—The Relation between the Activity of the Process and the Health of the Community.

We have seen that natural selection is still rigorously at work among men. Let us now inquire whether it is as rigorous in their case as among the lower animals.

This question is one of great moment to the pathologist, for, if the process of natural elimination be checked, the health standard will tend to be lowered; I had almost written, "*whatsoever* tends to check the process of natural elimination will tend at the same time to lower the health standard," but such a statement would not be altogether correct, for, by checking the spread of epidemics, for instance, we do not necessarily lower the health standard, because, as we have seen, the capacity of withstanding the deadly influence of a particular contagion is no true measure of health or bodily vigour. A sickly individual might fare better in this respect than a strong and lusty one. It is, nevertheless, possibly true that, by controlling the spread of epidemics, we have lowered the standard of health, though this is by no means necessarily the case. Such is the conclusion to which Crichton Browne arrives.* He thinks, for instance, that nervous diseases have, in this way, become more common. I am inclined, however, to receive this statement with some reservation, for I can see no connection between the nervous diathesis and susceptibility to the various contagia.

But whatever be the truth regarding the influence of diminished zymotic disease on the health of the community, there can be no doubt that the general diminution in mortality which

* *Vide British Medical Journal*, Feb. 11, 1888: Address to the Neurological Society of London.

has resulted from interference with natural selection must tend to lower the health standard. It therefore behoves us to compare the process as at work in man at present and in the lower animals.

The weeding-out process is quite as rigorous among savages as among many, at least, of the lower animals. This is at once obvious, for savage races do not increase in number, and, inasmuch as they are highly prolific, a very active weeding-out must occur. No doubt the population is largely kept down by infanticide, but we may be quite sure that there is in the main a "survival of the fittest." The process, I say, is as rigorous among savages as among *many* of the lower animals; but, since man does not tend to multiply at the same rate as most of these, fewer human beings need die prematurely than is the case with the animals that very rapidly multiply.

In those communities whose population is increasing, the process of elimination must necessarily be least rigorous; and this is the case with most civilized peoples.

In some few civilized countries, and notably in France, the population is kept at a standstill by a careful regulation of the births on the part of the parents. The tendency of this, as we shall see in the next chapter, is probably to lower the standard of health and to hinder the evolutionary process.

There is no analogy between a stationary population such as that of France and the population of a savage community, because, in spite of infanticide frequently checking the operation of natural selection in the latter, a larger number of children, in proportion to the population, are permitted to grow up than in a country like France, and an active elimination occurring among the adults by warfare and so forth, natural selection *is* permitted to operate there. Moreover, among many savages the practice of infanticide is unknown; in which case the population is kept down by continual warfare, and it is chiefly the inferior who are destroyed.

The cause of the increase in the population of civilized communities lies in the altered E. Whereas savages do little or nothing to increase the natural food supply, civilized peoples exert themselves to the utmost to make the yield as large as possible by tilling the soil, rearing live stock, &c.; and, taking

the various civilized communities one with another, the food supply has by this process hitherto been made sufficient for the most rapidly growing populations; for, if the total food supply of a country be insufficient at any time, one of two things happens: either there is an importation of the necessary food to it—this, of course, only occurring when the country contains an equivalent amount of wealth in some other shape, which it can offer in exchange—or there is a migration of the surplus population to some other part of the world where the adequate supply can be obtained. Hence, among the civilized, that great natural check to increase of population, the limitation of the food supply, has been removed.

We have further to observe that, by the mutual consent of the better-off, a sufficiency of food is placed at the disposal of the needy, so that, excepting those rare and isolated cases of starvation, and the now still rarer cases of widespread famine, there is no weeding-out among the civilized through lack of food, and hence the survival of many who, except for such intervention, would be destroyed.

Among this number we must distinguish two classes. There are, first, those who cannot obtain food through lack of the necessary mental qualifications—the lazy, the dissolute, or the actually incapable, it may be. Such are more interesting to the political economist than to the pathologist. Secondly, there is the class of the physically unfit. Very many individuals, simply because physically incapable of providing for themselves, would, in the ordinary course of nature, assuredly succumb. Such are either helped by their friends or provided for by the community at large, and it may be said of them that, in order to secure their survival, their E is rendered less *rigorous.*

Let me define this term. By it I intend to signify the amount of struggle which the E entails, or, what comes to the same thing, the difficulty of adaptation. I do not include under the rigorous E's those which are necessarily fatal: the term only applies to those to which the community is capable of becoming adapted. In contradistinction to a rigorous E we may speak of an "easy" one.

Now we shall find that the efficiency of S is in direct pro-

portion to the rigour of the E; or, to put it in another way, the greater the struggle against the E the higher the efficiency of S. This truth is well exemplified in the common affairs of life. Every one is aware that the efficiency of a railway service, for instance, is heightened by opposition. Organic evolution is indeed entirely due to rigour of E, and, so soon as that rigour is diminished, evolution ceases and dissolution begins. Examples illustrating this truth are so numerous and obvious that there is no occasion to mention any.

An adequate supply of food, then, being within the reach of every member of a civilized community, the E is thus far rendered more easy, and this will tend to check the progress of evolution, inasmuch as a number will continue to live who would otherwise die.

It must not be supposed, however, because the population of civilized communities is increasing and the food supply adequate for all, that therefore the struggle for existence—*using this term in the most literal sense*—is less among civilized than among primitive communities. The very fact that civilized communities *are* possessed of such enormous wealth and such abundant food supplies, as compared with primitive communities, shows that, taking one individual with another, the actual struggle must be far greater in the former, for the increased wealth is the outcome of increased labour. Most civilized men, having the capacity and the need for work, do it voluntarily, and play an active part in the great social machinery, so that, as a matter of fact, they struggle hard for existence, and, as a result of this struggle, man is still evolving to something higher than a mere bread-winner. But, although in this sense the struggle for existence is greater in civilized than among primitive communities, yet in another sense it is less severe, seeing that in all civilized communities there is a large number of individuals physically and morally incapable of providing for themselves, and such being, by the forbearance of their brethren, permitted to live, evolution to that extent suffers.

The E of civilized man is rendered less rigorous in other ways. The individual may be surrounded by the most "easy" E which it is within the power of man to create. In the first

place, he may possess hereditary wealth. In this case he does not require to struggle for food, and, like the parasite, is apt to retrograde, but such deterioration is rather a moral than a physical one, and does not immediately concern the pathologist. In the second place, the E of a sickly individual may be made easy by scrupulous and unremitting care. Have we to deal with a weak and sickly child, we may, by great care, and, it may be, skill, rescue it from a death which was otherwise certain, and the like is true of those suffering from many diseases, such as pneumonia, stone, strangulated hernia. Now, whenever life is thus artificially preserved, the operation of natural selection is interfered with. The physician is, in fact, part and parcel of the E of sick people, and whenever he rescues an individual not past the procreative period from a disease due to other causes than accident, he interferes with the operation of natural selection, and so far, by rendering the E less rigorous, tends to lower the health standard of the race. I advisedly say *tends*, for, as we shall see in a future chapter, the health standard is not in all cases thus necessarily lowered. If a number of sickly, delicate children are by skilful treatment successfully reared, the general health standard is necessarily lowered, no doubt, but the like cannot be said when life is saved by operating on a strangulated hernia.

Nevertheless, for the reasons just mentioned—*i.e.*, because sufficient food is placed within the reach of the weak as well as the strong; and, secondly, by reason of a wise and careful manipulation of the E—we may safely conclude that in civilized communities the physical health tends to deteriorate. The individual tends to become levelled down to a less rigorous E.

And what is true of the physical man is true also of the *moral*. A perusal of Spencer's "Sociology" will make this manifest. Therein he deals with the moral man. He points out the harmful influence on the poor of excessive State aid; for, in proportion as they are helped—that is to say, *as the E is made easy for them*—in that same proportion will there occur a degeneration of the moral self, so far, at least, as the capacity of self-help is concerned. Not only does no moral improvement result from excessive State intervention, but there is an actual levelling down of the individual to his more easy E.

Mr. Spencer does not, of course, contend that the E should not be as morally healthy as possible, but rather that it should not be rendered easy beyond certain limits which it should be the business of political economists to define, and, having surrounded the poor with a scientifically rigorous E, he would confidently look forward to a levelling up of the moral self.

In short, if an individual is helped too much, he generally exerts himself less to help himself. This is true of all organisms, whether plant or animal. I heard a good illustration of this quite recently, for on asking a gardener whether it would be advisable to water a particular kind of bean which had just been set, he said: "No; if you look after them too much, they won't look after themselves—they'll get the water right enough if left alone, but if you once begin to water them they'll always want to be watered." Thus, in his simple, practical language, he enunciated a most important and far-reaching law.

The physician is continually applying this principle. He knows well that, by physically pampering a child, he favours physical degeneration, just as moral pampering favours moral degeneration. And many of the particulars wherein the female sex is inferior to the male are, I believe, due to the difference in their bringing up—to the fact that the one has been subjected to a less rigorous E than the other.

It is clear, however, that we cannot regulate the physical E of the community at large with the precision of the political economist, saying, "To this extent shall your E be made easy, and no further." The reason is obvious: in the one case failure is a mere social one; in the other case it is a matter of life or death.

The above observations render it obvious that the weeding-out process is less severe among civilized communities than among the more primitive, and the causes of disease being greater in the former, we have a further reason why the standard of health should in them be lower.

And here let me allude to a common fallacy. Many point triumphantly to the fact that our own race is markedly increasing in size—that the average man of to-day is too big for the armour worn in bygone centuries, and so forth; and the evidence

in favour of this conclusion is very strong. It is true that the chest measurement of the recruit has been declining of recent years, but this is probably owing to the fact that more recruits are now drawn from the large towns than formerly. Granting, however, that the stature of the ordinarily healthy man is greater now than two or three centuries ago, it by no means follows that health has improved *pari passu* with this increase. Most domesticated animals are considerably bigger than their wild congeners, but they are, if anything, inferior in health and vigour. Their increase in size is certainly due to better diet, and good food undoubtedly tends to physical improvement. If all our agricultural population were perfectly fed, I have no doubt that, with their healthy* surroundings, a marked physical improvement would take place in the course of a few generations, and that health would improve in the same ratio. But against the increased stature and strength resulting from better food we have to set the thousand evils which accompany civilization, and which tend to mitigate the advantages arising from improved diet, and therefore it is that I say we must be careful not to point to mere increase in stature as evidence of an improved standard of health.

How far can this levelling down process go on? It is obvious that, taking the community at large into account, it cannot pass below a certain average level, and this by no means a low one. We have seen that, despite the more easy E which many members of civilized communities enjoy, natural selection is busily at work among them. This does not permit the physique and health standard to sink below a certain fairly high level; for although in a number of isolated instances sickly individuals are enabled to survive, yet this, be it noted, is true of isolated cases only. The community at large is exposed to a decidedly rigorous E; nevertheless, the population goes on increasing; and we may, I think, lay down the principle that a community rapidly increasing under a rigorous E must have a fairly high standard of physique and health. There must be a strong backbone to that community.

* I use the word *healthy* here, with the qualifications contained in the last chapter.

Under such a rigorous E, the searching process of natural selection is ever at work. The sickly ones who reach maturity in virtue of an artificially easy E do not live on through many generations. Though they survive, and though many of them rear children, Nature has, so to speak, her eye upon them, and sooner or later the unhealthy line is exterminated. The sickly and feeble will not, in fact, be represented in remote posterity; genealogically speaking, they are on the road to extinction. It is only the best physical specimens among us who can enjoy the prospective honour of living through their descendants in a remote posterity. These constitute the main stem of the genealogical tree: from it weak and slender offshoots are perpetually branching: for a few generations they live on, but sooner or later they break off and decay.

Wherefore, viewing the subject from a far-off standpoint, we see that a very high physical level of health must be maintained in the case of a fortunate few; and that the effect of rendering the E less rigorous is, on the whole, rather to delay the hand of Nature than to stop it. In estimating the average health standard of the community, however, we must include every member of it in our reckoning; and, such being the case, it is obvious that the health of *the community at large* is lowered by rendering the E less rigorous.

CHAPTER XII.

Natural Selection (*continued*)—Curtailment of the Number of Births in a Community hinders Evolution and favours Dissolution.

In the last chapter, while considering communities whose population does not increase, we had occasion to notice that this stationary condition of the population might be due to two causes: either to active weeding out, as in savage communities, or to limitation in the number of births, as in France, for instance, and I said that, whenever the number of births is thus curtailed, the health of the community must suffer, evolution being hindered. We will now briefly inquire into this statement.

In a large family, inasmuch as it is impossible to get equality, some of the children will certainly be more vigorous than others; *and some one must be the strongest and most vigorous.* Now, if the number of children which any one couple is capable of rearing be curtailed, and especially if it be limited to so small a number as three or four, the chances are against the potentially strongest individual being born, and so the nation is deprived of those who might have been its best children. Other things being equal, the most prolific nation has the best chance of physical improvement and the least chance of degeneration.

In reference to this tendency of any artificial check to population, it would be interesting to inquire at what particular period in the lives of the two parents the reproductive power is at its prime—*i.e.*, at what age the capacity of producing the best offspring exists? In France the father is often past middle life; and although this has its advantages, yet there can be little doubt that in the male the procreative power is at its prime before middle life. Late marriages on the part of the man are certainly not altogether favourable to racial

improvement; but there is another unfavourable circumstance attending artificial checks to increase—*i.e.*, that the children of women adopting this practice are generally born during the early period of their procreative life, and, in those cases where the father and mother are about the same age, when the father is young also. For, as a rule, the check is applied after the first two or three children are born at natural intervals; it is not, that is to say, applied so as to allow an interval of several years between the two or three children who are permitted to be born, in which case some of them might be born at the prime of sexual life. We must also take account of the fact that the first child is generally inferior to those immediately following; this is, at all events, the popular belief. From these several facts, it is obvious that a limitation in the number of births must tend to prevent the best children from being born.

So far as the intellectual side of man is concerned, there ought to be little difficulty in testing the truth of the above conclusion, since it is an easy enough matter to obtain a list of intellectual prodigies. I have taken twenty-two celebrated men at haphazard, with the object of discovering what position they occupy, in order of birth, among their brothers and sisters. The following is the result of my investigation:—

Poets:
- SHAKESPEARE, eldest son. Two daughters born before him. Both died young.
- TENNYSON, third son.

Painter:
- MICHAEL ANGELO, second son.

Musician:
- BEETHOVEN, second child, and son, of 5 sons and 2 daughters.

Ruler:
- CROMWELL, second son.

Philosophers:
- BACON, youngest son.
- KANT, second of 9 children.
- CARLYLE, eldest of 9 children.

Scientists:
- NEWTON, only child.
- DARWIN, youngest but one of 6 children.
- LYELL, eldest son.

Poet-philosopher:
- GOETHE, only son, eldest child.

Warriors:
- WELLINGTON, third son.
- ROBERT BLAKE, eldest of 13 sons and 2 daughters.

Statesmen-orators:
- CHATHAM, second son.
- BURKE, second son.
- GLADSTONE, youngest son.

Warrior-statesmen:
- CLIVE, eldest son.
- WARREN HASTINGS, only child.

Man of letters:
- SWIFT, second child.

Historian:
- GIBBON, eldest of 5 brothers and 1 sister, all of whom died in their infancy.

Novelist:
- DICKENS, eldest son; second child of family of 8.

In almost all the above cases it was impossible to discover in what exact order in the family the illustrious individual came. In the dictionaries and encyclopædias consulted, the sisters were left out of consideration.

It is remarkable how frequently in this list the intellectual prodigy has been the eldest son. This happened in the case of Shakespeare, Carlyle, Newton, Goethe, Robert Blake, Clive, Warren Hastings, Gibbon, Dickens—in nine out of twenty-two! Moreover, seven others were second children. Whether this proportion would be maintained in a larger list, I know not: I cannot but doubt it. Among the nine eldest sons, Shakespeare and Newton are certainly two of the greatest men who have ever lived—perhaps, intellectually, *the* greatest of whom we have proper record. Shakespeare, however, was the third *child*. So that, if only two children had been permitted to be born to his parents, Shakespeare would not have come into being. Nor would Darwin, Wellington, Gladstone—three of the most remarkable Englishmen of the present century. (Think how these three men have impressed European history and thought!) The same is true of the great Bacon, who was the youngest, and of Tennyson, who was the third son. From such a small number of cases it would be impossible to draw any general principles—moreover, no account is taken of the physical side of man; but even these few cases—taken, as I say, entirely haphazard—show most emphatically how much mankind would have lost by interference with biological laws.

CHAPTER XIII.

Activity of Natural Selection at the Different Periods of Life Compared—Its Influence on the Hereditary Transmission of Disease at these Periods—Natural Selection Inoperative after the Procreative Period—Non-Transmission of Evolutionary Gains after this Period—Average Limit of the Procreative Period of Life in the Two Sexes.

WE have seen how natural selection tends, by an active weeding-out process, to prevent the hereditary transmission of disease. It is evident that this process is inoperative after the procreative period of life, for, if a disease then kills, the race is in no way affected, the individual having already had abundant opportunity to leave offspring, who will, if the disease be due chiefly to peculiarity in S, tend to inherit it at the same period of life as that at which the afflicted parent suffered from it.

Natural selection operates most actively before the procreative period, for, if during this period an individual be destroyed by a disease due to faulty S, there is no possibility of his leaving offspring to inherit the disease-tendency. Similarly, it operates more rigorously during the early than in the later part of this period, because, when the individual is cut off in early procreative life, the possible progeny is less. In short, natural selection is most vigorous before the procreative period, inoperative after, and, during the period, severe in inverse proportion to the number of possible children.

We may, I think, safely conclude from the above that cases of fatal disease due to inherited structural peculiarity are least common before procreative life, that they gradually increase as it advances, and *suddenly* increase after its limit has been reached, not necessarily, however, becoming augmented year by year, for the process of racial elimination is as inoperative during the first as during the last year of post-procreative life.

Note that I say *fatal diseases*, for it is manifest that the minor inheritable diseases, which do not cause death, cannot fall under the influence of natural selection; and that I make the further qualification, *due to inherited structural peculiarity*—that is to say, not to peculiarities of E.

Now, there are several circumstances which render it difficult to test the truth of the above statement. In the first place, it is necessary to remember that many diseases begin early in life, yet do not kill till the individual is far advanced in procreative life or has actually passed it. A good example is afforded by rheumatic diathesis. I suppose the majority of people who suffer from rheumatism outlive procreative life; certainly many live on far into it. It is true that this disorder must diminish the chances of matrimony, but it is questionable whether it does so in a marked degree. It therefore follows that many rheumatically-disposed individuals may rear children, even though they have suffered from the disease in early life.

Then, again, it might be thought that the rate of the mortality at different periods of life would give us the proportion of inherited structural peculiarities at these several periods, but this is by no means the case, and for these reasons: First, the *disease-tendency* at the several periods of life is not the same thing as the *amount of disease*, because much depends upon the nature of the E. and this is more pathogenic during certain periods than others. Every one knows, for instance, that in men the mortality is largely increased by the nature of their occupation, by overwork, worry, accident, and so forth; that in women there are many disorders connected with their peculiar mental and physical surroundings; and that infants and young children, notably those of the lower classes, are (owing to defect in "reason" on the part of the parents) subjected to peculiar unhealthy conditions, such as improper feeding and clothing. Secondly, the disease-tendency at any particular period of life may not be due to any special inherited weakness, but to a condition of body more or less common to all members of one or both sexes at that period. Thus during the procreative period all women are subject to dangers from which they are free before and after this period. Children, too, are especially prone to respond

morbidly to certain mal-E's, such, for instance, as those just mentioned, not by virtue of any specific state of the tissue peculiar to this child or that, but in consequence of a condition of body belonging to the whole race at that time of life. If, therefore, we were to take the mortality of children as a measure of the extent to which special morbid tendencies are inherited, we should be erring, owing to the fact that children, as a class, are peculiarly susceptible to certain morbid influences, and to the further fact that they are freely exposed to these influences. I have purposely made no mention, hitherto, of the zymotic fevers. Is the excessive frequency with which children suffer from these zymotic fevers due to a peculiar susceptibility on their part, or to the fact that they are more exposed to a first attack of the poison than adults? It is probable that children are, on the whole, more prone to be affected by them than adults; but the chief reason of the greater frequency of the specific fevers during childhood is undoubtedly that one attack confers immunity from another, and that the great majority of adults have already been exposed to the poisons.

A further source of error is the fact that the longer an individual lives, the greater is the quantity of mal-E to which he is exposed. So that, other things being equal, the mortality would increase with each successive year.

In order to estimate properly the mortality at the several periods of life from disease due to inherited specific structural weakness, it would be necessary to expose an entire community to an average healthy E, and then, making due allowance for the above and all other possible sources of error, we should doubtless discover our inference to be correct.

We usually find very little disease before the procreative period which is not due to mal-E. For instance, the mortality in a properly regulated boys' school is very small, and this in spite of the fact that many of the boys have had their health injured by an improper bringing-up in the nursery.

It is very seldom, in fact, that we find children carried off by disease due to an inherited morbid taint. Indeed, if we eliminate the deaths due to the specific contagia, and to the neglect of the simplest sanitary laws, such as those pertaining to food, exercise, air, and clothing, we shall find that children

are rarely destroyed by disease. I have no hesitation in saying that, practically, all cases of bronchitis, "consumption of the bowels," and so-called "struma" (all of which cause an enormous number of deaths) are due to neglect—neglect as to feeding, ventilation, the simplest common-sense precautions. I say this deliberately. Can any one point to a single case of "struma"—say, hip-joint disease—in which the motions have not been for a long time unhealthy, in which that vast mucous tract whose business it is to convert the crude food-stuffs into suitable, soluble nutriment for the whole body, is not diseased? And what is the cause of this unhealthy state of the alimentary mucous tract, which of necessity leads to miserable and puny growth? It is due to errors in diet alone, or to this in conjunction with other forms of mal-E. In such a case the mother will probably tell us that the child has always been delicate, that for a long time, perhaps from earliest infancy, the motions have been unhealthy, and she will attribute all the trouble to an inborn weakness in the child; but on close inquiry we shall find in the majority of such cases that the initial fault is with the feeding, or other external conditions, and *not* with the child, or, even if with the child, that it was a mere temporary fault, one which, with judicious management, might have been easily overcome. And day by day the disease becomes more fixed, more difficult of cure; day by day the child grows more delicate, and the parents are more and more convinced that all the evil is due to an inborn weakness. When we remember that a mal-E acts perniciously in proportion as it acts early in life, we shall have no difficulty in seeing how a child's whole constitution may be modified for ill by a small initial neglect—that a long train of troubles may result from a simple malady which might very easily have been nipped in the bud.

It has been to me, for several years, a very interesting task to compare the health of brothers and sisters, and I have come to the conclusion that when one or two of a family are delicate while the others are healthy, the delicacy has always had such an accidental beginning, as we may call it; and, further, that in most cases where the *majority, or all*, the children are sickly, the cause is not an inherited weakness, but the faulty system of bringing-up to which all the children have been subjected.

It would, of course, be absurd to disregard altogether the influence of hereditary weakness, but I am convinced that, so far as diseases of children are concerned, this plays a very subordinate part, and that whatever weakness belongs to the new-born infant is rather the result of ante-partem conditions of E (of germ, sperm, and embryo).

I have tested the truth of the above statements by a large number of observations, and I could cite numerous cases where weakly infants have, with judicious management, grown up strong and vigorous, just as, on the other hand, I could give a dismal list (as who indeed could not?) of strong and vigorous infants who, through faulty management, have grown up into sickly, miserable specimens of humanity, if, indeed, they have not been actually destroyed in their infancy or childhood.

Inasmuch as natural selection does not operate after procreative life, it is important for us to answer the question: When does the procreative period terminate? Few women bear children after two or three and forty; in men, however, the reproductive power may extend into extreme old age. Nevertheless, the average age at which men cease to beget is much less than that at which the power leaves them, seeing that the wife becomes sterile a long time before the average husband is physiologically impotent. If we place the average age at which women cease to bear children at forty, and assume the husband to be on an average three years older than his wife, it will follow that the average age at which men cease to procreate is forty-three.

We may fittingly ask the question here, Is this limitation to the natural procreative period of the man advantageous or otherwise to the race? I cannot but see in it one serious disadvantage, namely, that racial evolution is prevented from taking place beyond this age. Whatever may be said of the physical side of our being, it must be acknowledged that the human mind is capable of much culture and improvement after forty or thereabouts, but, as things are, gains in this direction are lost to the race. It is, however, possible that the same applies to the physical side also. Suppose, for

instance, the men of twenty successive generations lead physically healthy lives till fifty-three years of age, then any individuals whom they beget at this period will reap the full advantage of ten years spent by the father in healthful physical life. Under existing circumstances, however, the race is largely deprived of this advantage, and it is needless to say that, as far as the hereditary principle is concerned, old age can have no influence on it, physically.

In short, the limit of procreative life, so far as I can see, practically determines the limit of evolution as regards age. Unless the procreative period be extended in women, we can never expect evolution in her to proceed beyond the present average climacteric period, but it might be pushed on to a much further limit in man. This conclusion follows from (1) the principle of heredity as limited by sex; (2) the principle of heredity at corresponding ages.

It is much easier to study the mental evolution of the human race than its physical evolution, for mental evolution leaves monuments as lasting as they are various. That the rate of evolution is different for the two sexes there can be no doubt, the female sex evolving more rapidly, both in mind and body, than the male.*

But whether the evolution goes on much longer in the life of the man than of the woman, I have not been able to satisfy myself. I have before me a series of notes which were taken with a view to estimate the rate and limit of mental evolution in the woman, and most of them tend to show the period

* The earlier occurrence of puberty in the female results, I suggest, from the fact that the sexual struggle has chiefly been among the males for the females. For the sake of argument, let us suppose that puberty occurred originally at the same age in both sexes. Directly the female attained sexual life she would be eagerly sought after; the younger males would, however, have very little chance in the struggle against older and more vigorous males, so that the tendency would be for the male sexual system to remain idle until some time after puberty; and, supposing this to occur for thousands of generations, it would follow from the principle of heredity at corresponding ages, and from what we know of the effects of use and disuse, that the onset of puberty would tend to be postponed in the male. If this explanation be correct, we may expect the period of puberty to gradually recede in the female, owing to the fact that the woman—at all events, in civilized countries—seldom marries until some years after puberty.

may extend far on into life. Of these notes I append the following:—

Madame de Staël, *b.* 1766; *d.* 1817.—Intellect very early developed, and remained unimpaired up to the last moment: great conversational powers, delighting intellectual men as early as 11 or 12. *Wrote nothing, however, of any importance till of middle age*—partly because of her father's objection, partly because her ideas found vent in her brilliant conversations. Her chief works were:

"Corinne"	aged 39–40
"L'Allemagne"	aged 42–44
"Dix Années d'Exil"	aged 46–47 (about)

Eminent Women Series.

Madame de Sévigné, *b.* 1626; *d.* 1696.—Bright and *spirituelle* from a very early age. Left no works from which to judge of the development of her intellect; but from her letters, which have been preserved, it is evident that her mind retained its vividness and brilliancy till the end. *Some of her most striking and original passages are to be found in her later letters.* She enjoyed excellent health all her life, having had only one illness (rheumatic fever, at the age of 50), besides small-pox, which killed her at the age of 70.

Miss Thackeray, *Foreign Classics.*

Maria Edgeworth, *b.* 1767; *d.* 1849.—Showed cleverness at an early age, and *retained a remarkable degree of mental activity up to her death, at the age of* 82. Wrote chiefly at her father's instigation (first attempt, "Letters to Literary Ladies," when 27), and at his death gave it up almost entirely, but continued to live an active busy life to the last. *At the age of* 70 set herself to learn a new language. Her best efforts are, perhaps:

"Castle Rackrent"	aged 33
"Ormond"	aged 50

Helen Zimmern, *Eminent Women Series.*

Harriet Martineau, *b.* 1802; *d.* 1876.—Began to write at the age of 20 (1822, chiefly essays), and continued to write voluminously (articles, political, philosophic, &c., and stories for reviews and magazines) till 64 years of age, when the pressure of ill-health closed her literary life. Her first success was not attained till the age of 29 ("Illustrations of Political Economy," 1831–2). She may be said to have reached the maturity of her powers about the age of 46.

"Eastern Life, Past and Present"	aged 46
"The Thirty Years' Peace"	aged 46–48

Though she stopped writing in 1866, her intellectual powers continued all but unabated till her death, at the age of 74. She had very bad health all her life, and for the last twenty-one years suffered intensely from the disease which ultimately killed her.

MRS. FENWICK MILLER, *Eminent Women Series.*

CHARLOTTE BRONTË, *b.* 1816; *d.* 1855.—Wrote tales, poems, &c., of considerable merit from the early age of 13. Her first novel, however, did not appear till she was 30; in the same year she wrote what is generally accepted as her masterpiece ("Jane Eyre," 1846). Her other two novels ("Shirley," 1849; "Villette," 1882—the latter by some people accounted her best) appeared at intervals of three years, her work being interrupted by very bad health, from which she suffered all her life. She was only 39 when she died, and would in all probability have done much more good work if she had lived longer. She belonged to a clever, precocious, unhealthy family.

MRS. GASKELL.

GEORGE ELIOT, *b.* 1819; *d.* 1880.—Her literary career extends over a period of thirty-six years. She began with translations at the age of 24, and wrote her last work ("Theophrastus Such") the year before her death, which took place at the age of 61. The following is a list of her works, with dates:

1848.	"Translations"	begun at the age of 24
1852–8.	Contributions to *Westminster Review*	begun at age of 33
1856–7.	"Scenes of Clerical Life"	aged 37–38
1859.	"Adam Bede"	aged 40
1860.	"Mill on the Floss" and "Lifted Veil"	aged 41
1861.	"Silas Marner"	aged 42
1862–3.	"Romola"	aged 43–44
1864–8.	"Spanish Gipsy"	aged 45–49
1866.	"Felix Holt"	aged 47
1871.	"Middlemarch"	aged 52
1876.	"Daniel Deronda"	aged 57
1879.	"Impressions of Theophrastus Such"	aged 60

MATHILDE BLIND, *Eminent Women Series.*

GEORGE SAND, *b.* 1804; *d.* 1876.—Began to write at the age of 27, and continued to do so with unabated vigour *till within a few days of her death, at the age of* 72. She cannot be said, for any length

of time, to have risen above or sunk below a certain level of excellence. From the time of her first novel ("Indiana," 1832), written at the age of 28, she continued to produce at the rate of two novels a year, and at rare intervals was the product a failure. *The power shown in her earliest works is to be seen in an equal degree in those of* 40 *years' later date*:

"La Marquise" . . . . aged 28
"Francia" . . . . aged 68

BERTHA THOMAS, *Eminent Women Series.*

MARY WOLLSTONECRAFT GODWIN, *b.* 1759; *d.* 1797.—It may be said that her intellect did not awake till she was 16, when she first began to study, and that it *went on developing till her death.* The work on which her fame as an author rests ("Vindication of the Rights of Women," 1791) was written at the age of 32. Her next work (on the "French Revolution," written two or three years later, 1793–4) marks an enormous advance in her mental development. She died at the age of 38, in the full prime of her powers. *Her best work probably remained to be done.* The increased merit of her later work somewhat confirms Southey's declaration that "M. W. Godwin *was but beginning to reason when she died.*"

ELIZABETH ROBINS PENNELL, *Eminent Women Series.*

It would appear from these few cases, chosen at random, that mental evolution goes on as long in the life of the female as the male, and this accords with the conclusion arrived at *à priori*—namely, that the limit to evolution would be about the same in the two sexes, seeing that the *actual* procreative limit is about the same. Judging from these examples, it would seem that the climacteric exercises no injurious influence upon the intellectual faculties; indeed, some of the most brilliant work appears to have been accomplished at this period. That the wave of emotional excitement which comes over the woman at the climacteric tends to give a distinct colouring to the work then produced, I can have little doubt, but it has surprised me somewhat that there is no evidence of even a temporary intellectual falling off among celebrated women at this time; this, however, is not the place to discuss the subject further.

CHAPTER XIV.

Sexual Selection.

I HAVE considered the part played among civilized peoples by natural selection. There are two remaining factors which help to mould the animal organism—namely, sexual selection; and the direct action of the E, independently of natural or sexual selection. It will be unnecessary to speak of these at great length.

Sexual selection plays, comparatively speaking, a very inferior part in moulding civilized man. It will be advisable to treat of it, first, from the point of view of the man; and, secondly, from that of the woman.

1. As regards the *man*.—Among savage peoples the strongest and most vigorous men, doubtless, secure the largest number of wives, and leave behind them the most numerous progeny, but in civilized communities monogamy for the most part prevails; wherefore, one male cannot well leave behind him more than a limited progeny; for, although promiscuous intercourse frequently occurs among civilized communities, and illegitimate births are frequent, yet the children born to any one man in this way cannot be very numerous. Even supposing, however, one man to leave a large number of illegitimate children, it by no means follows that such a one enjoys exceptionally good health and strength, or a total freedom from disease taint, seeing that the tendency to beget illegitimate children depends upon a moral, not upon a physical depravity on the part of the parents. Indeed, the procreative power bears little or no relation to physical fitness; for it is well known that feeble and unhealthy parents are frequently capable of rearing large families, while, on the other hand, strong and healthy parents have, often enough, very few children.

Thus, whereas in a savage community the inferior physical types stand little chance of rearing offspring, in civilized countries the sickly individual, possessing, as he unfortunately does, the power of procreation, can, practically, always gratify his desire for offspring, for there is little difficulty in securing a wife. Many women have assuredly highly crude notions concerning physical fitness, so much so that a sickly man is often voted "interesting;" and although one can scarcely go so far as Thackeray, who tells us any man can marry any woman, yet I think it will be generally allowed that there are few men desiring matrimony who cannot gratify their wish. All may not succeed in the first instance, but he must indeed be a very bad specimen of humanity who meets with universal failure.

Men are, moreover, actuated by other considerations than those of physical fitness. There is a beauty of mind as well as of body. A noble mind is an irresistible force, and it is well that it is, for so the superior mental type tends to be propagated. Hence we may fittingly speak of a "mental fitness;" and are not many mentally *unfit* to marry, some because incapable of acting up to the full morality of married life, others because possessing minds too degraded to be transmitted to posterity?

And here I would ask—Does the thought often occur to those who desire to marry and to have children, "Am I worthy to be represented in posterity? Have I myself been such a success that I should wish to leave another like me?" I doubt not that, as regards physical ineptitude, the question does very frequently arise, and that the answer is usually—"*No!*" But what of mental ineptitude? Life has pain and troubles for all. Some are so constructed, are so buoyed up with animal spirits—and a precious heritage they are—that they ride safely through the storm and tempest of life—the pains and sorrows of to-day melting into the ocean of the past to-morrow, and forgotten. This is physiological. But there are others—and they are many—who are keenly alive to the pains and trials which all must suffer, who are apt to brood unduly over the mysteries of life, for ever seeking to gaze into the unfathomable. Ought such to marry? I think not. The hypochondriac is often

advised to do so. It is argued that, with the affection of a good woman, and with the diverting interests which children bring with them, he will be gradually drawn out of himself, and will forget his imaginary ailments. Be it so. But is not such a course a highly selfish one? The true hypochondriac is a pathological variation, and should think twice before he determines to multiply the number.

Wealth constitutes a further attraction for men, and this is a possession that by no means goes hand in hand with either mental or bodily fitness. Young men are perpetually counselled by their elders to "look out for money." The advice of the "Northern Farmer" is, perhaps, less objectionable: "Doänt thou marry for munny, but goä wheer munny is." Among the lower orders wealth is assuredly a greater attraction for the men than physical fitness: a deformed cook, with small savings, would, in many cases, be deemed a greater prize than a penniless beauty, and it is truly astounding how large a number of crippled women get married. No doubt, in marrying women with money, a particular type of mind is unconsciously selected. A saving cook is a prudent woman, and an heiress comes of a stock in whom the faculty of acquiring wealth is prominent. Galton has remarked of heiresses that they tend to have few children: this is what we should expect; for the fact of their being heiresses often depends upon small procreative power on the part of one or other of their parents, and this writer very ingeniously accounts for the rapid extinction of many newly created peerages by the frequency with which the eldest son marries an heiress—marries into an unproductive family.

In spite of the above facts, it must be allowed that sexual selection, considered from the point of view of the man, does play some part in moulding the race. In the first place, there are some men who are actually incapable of procreation, either through a general feebleness of constitution or local sexual defect. In the next place, it must be granted that there are also some rare individuals whom nobody would have at any price. Finally, there are men who either do not care to marry, or who, while wishing to do so, have not the means. Unfortunately, this latter is no great obstacle among the poorer classes.

It is obvious, from these considerations, that particular bodily and mental types tend to be eliminated.

2. From the *woman's* point of view. Since there are more marriageable women than marrying men, a large number of women remain unmarried. No doubt, the most beautiful specimens get married; but if we except what may be termed the exceptionally beautiful, whether in body or mind, who are eagerly sought after, the chances which the remaining number have of being married are about equal, always eliminating the element of wealth. A certain number of women prefer spinsterhood, and their number is probably larger than is generally known, for so great is the tendency to believe otherwise that few elderly spinsters are accredited with having remained in spinsterhood for its own sake. In the case of women, choice is frequently influenced by considerations of social position. How often do we see women of surpassing physical beauty wedding the most miserable male specimens for the sake of rank? Such unions must surely grate upon the feelings of the physiologist and anatomist—ay, and of the moralist, too. On the other hand, the instincts of a lovely woman—using the word *lovely* in its widest sense—are averse to such a union, and she happily often mates herself with her equal. It is from these unions that the ancestors of remote posterity spring. They should in every way be encouraged; and I hold that every parent who can rear a family of children healthy in mind and body, may justly, like the Vicar of Wakefield, consider his country his debtor.

CHAPTER XV.

Action of E upon Structure independently of Selection.

A PARTICULAR E acting during several successive generations is able to modify the structure of the organism in a particular way independently of selection, natural or sexual. This factor, however, has played a very subordinate part in evolution. It is chiefly natural selection, and in a lesser degree sexual selection, which have brought about the complex specializations of organisms.

Now, selection can have played no part in the evolution of disease, since all pathological variations, far from being *selected*, tend to be *weeded out*. "Natural selection acts exclusively by the preservation and accumulation of variations which are beneficial under the organic and inorganic conditions to which each creature is exposed at all periods of life. The ultimate result is that each creature tends to become more and more improved in relation to its conditions."* Thus selection is ever busy tending to prevent disease, and I wish to draw particular attention to this fact because we hear a great deal about the "evolution of disease." But it is obvious that if a disease evolve during several successive generations, it must essentially be by this third method—viz, by the action of E upon structure, independently of selection.

I use the term "evolution of disease," but it must be confessed that it is somewhat paradoxical, for disease is essentially a *dissolutionary* process, and it would, therefore, be more accurate to speak of the *dissolution* of disease. Indeed, if we hold by the meaning attached to the word by Herbert Spencer, the illustrious propounder of the doctrine of evolution, we cannot, without contradiction, speak of the evolution of

* "Origin of Species," p. 97.

disease. When due to pathogenic germs, a disease may, it is true, evolve by natural selection or otherwise, since here the specific mal-E is a living organism, which in mode of evolution differs in no wise from other organisms, but in such cases the evolution belongs to the E and not to the S. When, however, we speak of the evolution of disease, we are not referring to the evolution of a pathogenic organic E, but of a structural state on the part of the suffering organism—a change wrought in the S, it may be during several successsive generations.

Repeated allusion has been made to the influence of a mal-E operating during several successive generations. All the necessarily-fatal-E's which do not kill in the first generation operate in this way. There is a gradual deterioration in structure which eventually leads to family extinction, and in such cases there may perhaps be said to be an evolution of disease. The S during successive generations is gradually modified in such a way that presently S + a particular E, which perhaps would have no ill-effect upon a healthy individual, induces a fatal disease.

In this way many disease-tendencies—*e.g.*, to insanity and gout—are slowly evolved.

Intemperance is so well known to be a fruitful cause of insanity that we might, in certain cases of this disease at all events, have little difficulty in tracing its evolution during successive generations and in determining its proper cause, and the same is true of gout and other disorders. But how many are the subtle causes of disease which quite elude our observation! Generation after generation of men exposed to an ever-operating but unknown E may in this way be gradually and imperceptibly changed in the direction of disease. Such changes are of course structural, and constitute natural variations; they are wrought in the finer textures of the individual, and for long may lead to no *obvious* change, but finally, after several generations, the specific E calls out the actual disease, which is then recognizable as a true pathological variation.

Now it is interesting to note that this is exactly what happens in the case of ordinary physiological variations. A gardener has often to alter the E of a plant for many

generations before he can get it to vary at all. A hidden silent change meanwhile goes on, the tendency to *obviously vary* increasing: the numerical value of S rises from 1 to 10. "We have good grounds," says Darwin,* "for believing that the influence of changed conditions accumulates, so that no effect" (he evidently means here *obvious* effect) "is produced on a species until it has been exposed during several generations to continued cultivation and domestication."

Our case of insanity is therefore parallel with the variations of wild plants under domestication. In both a peculiar E operates during many generations, leading to a hidden specific change, which finally breaks out into an obvious variation—physiological in the one case, pathological in the other.

* Vol. II. "Animals under Domestication," p. 249.

CHAPTER XVI.

Criticism of Dr. Mott's Views—Concluding Remarks on Evolution.

In concluding my remarks on evolution, I should like to allude to an interesting and suggestive paper,* which I read after the foregoing chapters were written. The object of the author is to show that "the outcome of modern intellectual development in the production of great social changes is to produce a widespread physiological dissolution—namely, a lowering of the vitality of the individual."

As the result of civilization, the rich, he tells us, get too much, the poor too little; people, moreover, tend to accumulate in unhealthy towns, to suffer from alcoholism, syphilis, overpressure of business, &c. A further evil, he believes, results from the fact that artificial selection is "replacing natural selection," and that medical science preserves degenerate types. So far (as my remarks have, I hope, made clear), I entirely concur with this author, but I think he under-estimates the influence of natural selection among civilized peoples. Imperfect and inferior types are, as I have shown, being perpetually weeded out. Moreover, we may, I believe, conclude that so long as the population of a country (like our own, for instance) goes on increasing, the physical standard of the nation, *as a whole*, must keep at a high level, for, owing to the rigour of the E—which is in direct proportion to the severity of the struggle for existence—a high average strength is required.

I further take exception to another opinion which Dr. Mott arrives at. In a huge, social organism like London, where waste and repair are ceaselessly going on, fresh material for assimilation is provided in the shape of a continually in-pouring populace, notably from the country. But Dr. Mott believes

* Dr. Mott, *Edinburgh Medical Journal*, April 1887.

that the agricultural population itself is dying out. He adds: "This refreshing influence on town population has almost reached its limit, and it seems to me that nothing but a grand scheme of State-aided emigration will serve to relieve the plethora of our overgrown cities." Now, if the immigration of country folk has reached its limit, there is no need of thus relieving our congested towns. As we have already seen, family extinction proceeds rapidly in large towns; and if country and other immigration should cease, the town population would probably sooner or later begin to diminish. A fair standard of health is kept up in the suburbs, and it is from these that the resident population in the more central parts would, in such a case, have to be replenished. That the waste would be repaired with marvellous accuracy and celerity from some source or other there can be no doubt, for fresh openings would be perpetually recurring, and we know how wonderfully the balance between supply and demand is kept up. For my part, I see no reason for believing that the supply from the agricultural population will fail, for we must remember that human beings tend to increase in geometric proportion. But even supposing that it should fail us, are we to believe that there is no other pabulum to feed the organism? There are countless people scattered over the globe who would soon find themselves in our own great city, for instance, if the necessary openings presented themselves, and a "grand scheme of State-aided emigration" would merely result in a grand counter-scheme of immigration which would require but little State-aid.

I cannot, therefore, agree with Dr. Mott when he concludes that the physiological dissolution which inevitably attends civilization must necessarily tend to the decay of nations. Dr. Mott attempts to fortify himself in his conclusion by citing the well-known fact that every civilization has had its growth, arrest, and decay; but has this decay always, or even ever, gone on, *pari passu*, or with the growth, arrest, and decay of the physiological unit, viewed in its physical aspect? Can we trace the decadence of past civilizations to such physiological dissolution? Rather shall we find its origin in an intricate web of causes—political, social, economic,

religious—an origin due in large measure to the subtle play of the human mind—and what will determine the decay of our English nation—if decay there must be—will assuredly not be any change which the physiologist can point to, but one belonging to the region of social and political economics.

To sum up:—We have seen in the last chapters that direct equilibration (the operation of E upon S independently of selection), indirect equilibration (natural selection or survival of the fittest), and sexual selection are all operative among civilized men, though in varying degree.

No doubt Herbert Spencer is correct when he tells us that natural selection does not play such a potent part in modifying structure among the higher orders of animals as among the lower. We must, nevertheless, not neglect the part played by it, and from the pathological point of view I venture to think that its operation is still of the utmost importance. In order to realize adequately how important a part natural selection has taken in the evolution of our race, we must bear in mind that each one of us has an ancestry stretching far back into the dim past, through countless generations of life growing ever simpler till the unicellular protoplasmic unit is reached, and that each individual in this long chain has successfully contended against many competitors—has varied in the right direction. The mind fails to grasp the number that have been unable to struggle against the conditions of their E, and the enormous destruction of life the operation of natural selection has entailed. The present population of the world is as nothing compared with what it would have been had no process of elimination taken place, always supposing (what is, in fact, impossible) that evolution could have taken place at all without such elimination.

And as it has been in the past, so it is now. Natural selection is not so active among civilized, as among primitive, communities, a fact which the rapid increase in the population of many civilized countries at once attests. Nevertheless, now as always, individuals are born who are incapable of coping with their E. Often enough—indeed, only too often—the E is a necessarily fatal one—destroying ruthlessly, no matter how

strong and vigorous the body: but over and above such necessarily-fatal-E's, there are numerous forms of E which, while they induce disease in many, have not power to hurt all, or, if capable of hurting, are incapable of destroying all. To such E's adaptation is obviously possible by a process of natural selection, and in this way numbers are carried off by rheumatism, heart disease, tubercle, and similar disorders, induced by conditions which have no power to harm their more fortunate brethren. Such unlucky variations are, no doubt, often enough the result of ancestral mal-E, but not necessarily, for an individual may so vary as to become unduly susceptible to some contagia—for instance, the tubercle bacillus, or other similar agents incapable of working harm on the average healthy individual—even though he and his more immediate ancestors have been sound in body and healthy in mode of life. The like is true of many diseases. Wherefore unfit variations must necessarily occur from time to time under the most perfect hygienic system, and *à fortiori*, under that quantity of mal-E which is the common lot of all—the necessarily-mal-E. Whatever, therefore, the far-off future may bring with it in the way of hygienic advance, disease must ever remain a necessary evil; and, although much improvement will unquestionably take place, let us bear in mind that the instability of E will certainly tend to increase with the steady progress of evolution, and that this instability is a great check to perfect adaptation, whether affected through natural selection or otherwise.

PART III.

CHAPTER I.*

The Distinction between a "Natural" and an "Artificial Environment."

We have seen that an adaptation, both personal and racial, is continually taking place to the E obtaining in civilized communities, and that this adaptation consists in a structural change. We have further seen that man obtains an ever stronger and more complete control over his E as evolution advances, for it becomes more and more the result of complex mental operations. Already this control has reached a high pitch, and civilized man has surrounded himself by an E which differs widely from the comparatively simple E of a primitive community. The former is usually spoken of as an "artificial" E, the latter as a "natural" one; and it is necessary for us to ask ourselves if there is any fundamental difference between the two, for it is very certain that, as time advances, the E will tend to become more and more artificial, and the question arises: What effect will this have upon the health of the race?

In our study of this point we had best direct our attention to one or two very highly artificial forms of E, and the conclusions which we shall arrive at concerning them will be, *à fortiori*, applicable to less artificial E's.

Practical surgery constitutes a highly artificial order of E. A patient suffers, let us say, from ovarian cyst, strangulated hernia, or stone, from any one of which diseases he must

* In some of the following chapters the reader will find here and there a repetition of what has gone before. This is notably the case with the chapters on "Normality of S and E," and on the "Origin of Cancer." I shall be pardoned, I trust, for these repetitions, since they tend to emphasize points which seem to me important.

needs die unless placed under proper surgical treatment. The surgeon stands in the relation of a specific form of E to such a sufferer, who, if he be placed amid the artificial E created by surgical skill, may be, practically, always rescued from otherwise certain death. Delivery by forceps and the artificial rearing of infants are other modes of artificial E: upon them, indeed, the lives of many children depend.

The physician occupies a similar position to the surgeon, and, although he cannot claim such rapid and startling results, there can be no doubt that numbers come safely out of illnesses, which, but for his skill, would necessarily destroy them; delicate children also are frequently, by a careful regulation of the E, enabled to survive.

In like manner, many domesticated animals are wholly dependent upon the artificial E supplied to them by man; for instance, some kinds of camel cannot be brought into proper sexual connection without man's aid, and bees may become so vitiated in instinct by artificial treatment as to be absolutely dependent upon the help of man.

Now, what effect upon the race has the interference of the doctor? It is manifest that the process of elimination is checked, and the amount of disease thereby increased; for not only are diseased individuals kept alive, but they are enabled to rear offspring to inherit the like diseases. Thus, while benefiting the individual, we help, as we have already seen, to cause racial deterioration.

I am careful to say, "help to cause racial deterioration," for it will be presently manifest that these artificial checks to natural elimination need not in all cases have such a result. We must first, however, answer the question: Is there any intrinsic difference between a highly artificial form of E and so-called "Nature"? We will take as an instance that most highly artificial E—surgical skill. Given this E, then ovarian cysts, vesical calculus, and strangulated hernia are compatible with life; wherefore it follows that the human race might persist, even though these diseases became universal, provided the necessary surgical skill were at hand. Hence whereas S + natural E = death in some cases, S + artificial E would be consistent with continued healthful life. If, then, all indi-

viduals were afflicted with one or other of these diseases, the surgeon would become as necessary a part of man's E as oxygen, and, under the artificial E supplied by him, the human race might continue to flourish in undiminished vigour. Perhaps I ought not to include stone under these remarks, since this disease is not a local one; but the other two, strangulated hernia and ovarian cysts, are strictly localized, and from either of these an individual may suffer, and yet be in all other respects perfectly healthy. Indeed, the race is already being modified by the artificial E of surgery in the manner indicated, and not necessarily for the worse. Through untold ages there has been a destruction of individuals suffering from ovarian cysts and strangulated hernia, and a survival of those only who are not afflicted with these diseases; but the process of elimination being now checked, the number of afflicted individuals is necessarily increasing, and yet, since the necessary artificial E in the shape of surgical skill is at hand, with no necessarily deteriorating effects on the race.

In like manner, it is theoretically possible for the mother and infant to become permanently modified by the continued use of the forceps. Such an artificial mode of delivery, carried on through many generations, would necessarily lead, through disuse, to diminished expulsive power of the womb, so that, in course of time, delivery would become impossible without artificial help. The number of cases of post-partem hæmorrhage would probably be increased for a time, but a proper adaptation to the new order of things would assuredly occur through natural selection, and that, too, very possibly, without any racial disadvantage, for the children, in their turn, would become permanently adapted by a survival of those best able to withstand the evil pressure-effects of the forceps. I am not, of course, contending for an indiscriminate use of this instrument; any such adaptation as I hint at could only be effected after a terrible sacrifice of women and children. I merely wish to show that a perfect adjustment between the S and such a highly artificial E might, in the end, result.

The same line of argument applies to the artificial rearing of children. The time may come—nay, I almost believe it will come—when the mammæ of woman shall have disappeared, and

when all infants will be reared by hand. Mammary atrophy is, I believe, already taking place among the upper classes.* There is nothing to make it impossible that infants should, by a terrific weeding-out process, become thoroughly adapted to artificial feeding, those only surviving whose digestive organs varied in the direction of being able to digest artificial food.

Yet another instance may be given. The teeth of many nations appear to be undergoing rapid degeneration, so much so, indeed, that some have supposed that man will eventually be a toothless animal, requiring, as a matter of course, artificial teeth for mastication. Now, although I have my doubts as to whether this will ever happen, I do not for a moment doubt that it *could* happen, and, under these circumstances, it would appear as natural to wear artificial teeth as to wear boots, or to eat with a knife and fork.

From the above instances, it is obvious that a race may adapt itself to certain most highly artificial forms of E. I say, certain of them, not all; for many forms of artificial E are, as we have seen, *necessarily fatal*—that is, quite incompatible with racial existence.

Now, the fact that perfect adaptation to artificial forms of E is possible, raises the question, Is there any fundamental distinction between a so-called "natural" E and an "artificial" E to which adaptation has already occurred? There is a strong tendency to the belief (such is my experience) that as civilization advances, and men live more and more artificially, they must necessarily degenerate, and the ground for the belief is that they do not lead "natural lives." But when we reflect that natural selection is playing a conspicuous part among civilized men, a doubt at once occurs as to the truth of this assumption. For, viewed in the light of evolution, it is obvious that the "artificial" E does not stand in any broad antithesis to the "natural" E (say that of the savage), or what would be vulgarly called *Nature*. There is nothing intrinsically peculiar in the natural E, since it differs for the different orders of brutes, each species of which inhabits its own particular E,

* It is quite possible, though not probable, that the mammæ will be retained through sexual selection, even though their secretive function be lost.

an E to which, in the course of ages, it has become adapted. This harmonious working between each individual and its specific E is the outcome of personal adaptation and natural selection—of direct and indirect equilibration. What may, therefore, be termed the natural E of an animal is that E to which, in the course of ages, it has become adapted. Now the human race is *adaptable* to certain forms of artificial E, and when, by natural selection or otherwise, perfect adaptation to any artificial E is effected, that E becomes in its turn quite as "natural" as the E of the savage. A savage, if he understood his relation to his comparatively near relatives, the apes, would no doubt think his E very artificial as compared with theirs.

To sum up, the only criterion of "naturalness" is the degree of adaptation; perfect naturalness means perfect adaptation, and thus it may well be that an E which we regard to-day as highly artificial—such, for instance, as the artificial feeding of children—will in the future come to be looked upon as quite natural.

Although I have frequently used the term "artificial" E, I have not yet attempted a definition of it. The best definition I can give is: "An E determined by an elaborate reason." If we did not qualify the word "reason" in some way, it would follow from the definition as it would then stand that the E of the most primitive savage, and of many of the higher animals (I exclude the domesticated animals) would come under the head of artificial E's. The definition is, however, very imperfect, from the fact that "elaborate" is, in common with most epithets, a comparative term, but, in truth the case admits of no better, inasmuch as "artificial" is also comparative, and the thing to which it is attached, therefore, does not admit of an absolute definition.

As we ascend the scale of life, we find the enviro-regulating apparatus becoming more and more complex. Starting as a simple, undifferentiated nervous system, it passes through the successive phases of reflex mechanism, conscious reflex mechanism (or simple instinct), and finally, reasoning reflex mechanism, the latter obtaining only in man and the higher brutes. And, side by side with this growing complexity of the E-regulating system, there is a corresponding increase in

the complexity of the E. Now, remembering our criterion of naturalness, when are we to say that the artificial E begins and the natural E ends? The E of the ape-like man, as we look back and try to realize it, appears very artificial as compared with that of his more primitive ancestors; that of the savage, again, highly artificial as compared with the E of the ape-like man, and our own stands out as yet more highly artificial compared with that of the savage. Yet to all there is, or has been, adaptation; and since the extent of the adaptation determines the degree of the "naturalness," the limits of what can be termed artificial E become more and more restricted. The same line of argument might be pursued in respect of any member or section of a civilized community having increasingly complex E's; and, viewing the matter thus, it becomes yet more evident that there is no sharp distinction between a natural and an artificial E.

CHAPTER II.

What constitutes Normality in Structure and Environment—Definition of Health—Test of Healthy Interaction—The Actually and Potentially Normal—The Inevitably Abnormal—Justification of the Term Resistance as Applied to Disease.

In treating of life we have to make a distinction between (*a*) the organism, and (*b*) its environment. If each of these be properly constituted an inter-action takes place, and there is healthy life. If S be normal and E be normal, S + E will represent a set of material conditions which will inevitably issue in healthful vital action.

I say, if S and E be normal; but is it possible to define a normal S and a normal E? Is there a criterion of normality of S and E—a fixed standard capable of rigid definition? The answer is certainly *No*, although we are somewhat apt to assume one.

What, then, is to be understood by a normal S or a normal E? In answering this question the great fact to be borne in mind is that it is quite impossible to define either without reference to the other. Life being a two-sided process, of which the one side is represented by S and the other by E, we may say that when S + E results in healthy inter-action, both are normal; each is normal as regards the other. But if S + E results in morbid action, both are abnormal; each is abnormal as regards the other.

This position will, I believe, shortly be rendered evident, and meanwhile we must ask what constitutes *healthful interaction* of S and E. The reply is that a condition of S and E which will permit life to go on without the slightest pain, and with the fullest possible enjoyment of it, until death occurs through sheer wear-out, represents the ideal of health. In such a case both S and E are perfectly normal. On the

other hand, if there is any peculiarity of the one or of the other which shall lead to pain, or shall cut short by a fraction of time the full term of life, the inter-action is morbid, and S and E are abnormal.

But another question arises—Can we always be certain that the inter-action is healthful? Can we always assert confidently that a particular E is not working an injurious influence upon the body? I think not, for a long time may be required to render the evil obvious. An individual, for instance, indulges for many years in alcohol, not, apparently, to an injurious extent, for he seems to enjoy good health. Suppose, however, that, as a result of such indulgence, his life is shortened by never so short a time, it is obvious that, though no evil effect has manifested itself concomitantly with the indulgence, the alcohol has nevertheless all along been operating injuriously. Perhaps in such a case we should be able, on close scrutiny, to detect distinct evil results, such as morning headache, occasional indigestion, or what not; but on the whole it is doubtful whether the insidious effects would indicate themselves at all at the time. Few, I think, will deny that an injurious E may work altogether silently and unperceived. We may take as another instance the case of a man living in London under the most healthy conditions which he can command, and enjoying in his own belief, and, indeed, to all appearances, perfect health; he dies, let us suppose, from causes more or less natural, at the age of seventy. Now, it may well be that, had this man spent the latter years of his life in the country, he would have lived five years longer than he did in London, in which case there could not have been perfectly healthy inter-action, as we have defined it, in London, in spite of no indication to the contrary.

But although it may not always be easy to say whether healthy inter-action between S and E is taking place, such inter-action, however imperfect our estimation of it, is the only criterion of normality of S and E.

It must not, however, be supposed from the above remarks that there is no such thing as an absolute and inevitable *abnormality* of S and E. The following statement sums up the whole truth respecting normality of S and E.

If the S is so constituted that healthy vital inter-action is impossible under any conditions of E, that S is absolutely and inevitably abnormal; and conversely, if an E is such that no S can respond healthily to it, that E is absolutely and inevitably abnormal. But if a set of conditions exists in which the S can act healthily, that S must be regarded as possessing, at all events, a potential normality; and conversely, if there is a set of conditions to which some individuals are capable of responding healthily, that E is normal to them.

In order to show how normality of S and E can only be considered in relation to one another, let us take, again, the instance of a coloured tribe living healthily in an ague-stricken district. Here S + E results in perfect health, and, therefore, both are normal—the S on the one hand, and the E (including the ague poison) on the other; for this being incapable of striking disease into these black people, it is not abnormal to them, and therefore must be normal. Let us further take the case of a number of white men living healthily amid an ordinary civilized E—say, in England. Here again both the S and the E are normal—health being the criterion of normality for each. But now let the white and the black change places: the former would quickly sicken in the ague-stricken district, and the like would in a large degree be the fate of the black suddenly transplanted to a civilized E. The black might, with some show of justice, exclaim: "These white men are unhealthy creatures, for they sicken and die in this district where we thrive so well;" while the white, with equal justice, might retort: "You blacks are poor, sickly, unhealthy creatures, for you rapidly sicken under this healthy E of ours." Hence this paradox—the structure of each is both normal and abnormal; each is normal to its own particular E, but abnormal to the other. The clue, as I say, to the situation is this: normality of S has no meaning by itself, and can only be considered in relation to E. Every individual who can live healthily in a particular E is structurally normal as regards that E, and there is no fixed normality for all. The same is true of the several forms of E. E must always be considered in relation to S, and any E is normal to a particular S if it permits that S to live healthily amid it. Thus an ague-engendering E may be normal to some, but virulently

abnormal to others, and this is true of many other similar E's. Many individuals, for instance, are incapable of being injuriously affected by the poisons of the specific fevers, and, so far as such individuals are concerned, the presence of these around and about them does not constitute abnormality of E. Who knows, indeed, how many unseen agencies there may not be about us, which, in days gone by, were capable of working great ill upon our race, but which, by adaptation through the course of long ages, have come to be quite innocent—agencies which once constituted an abnormal E, but which are now quite normal. And what is true of the poisonous products of micro-organisms is doubtless true of innumerable simple forms of E. The homely saying, "What is one man's meat is another man's poison," bears witness to the truth of this. To some, for instance, ordinary quantities of alcohol are quite harmless—nay, they may even be beneficial; to others—*e.g.*, the rheumatic and gouty—they are actually poisonous. In the first case, S and E permit the vital processes to proceed healthily: each is normal as regards the other. In the second case, unhealthy action results: each is abnormal as regards the other.

Let us now turn to some of the more complex forms of E. Those of which we more particularly spoke just now are of the simplest kind, consisting, in fact, of a simple agent—namely, some animal or vegetable substance. The E of an individual, however, consists of the sum total of influences (mental and physical) operating upon him, and hence it follows that E is infinitely complex and diverse. A long chapter would be needed to illustrate the complexity and diversity of man's E. My purpose, for the moment, is to call attention once again to the diversity of E in a civilized community more especially. In a primitive community the E is very much alike for all, but as the division of labour proceeds in the social organism, we have in the same community a multiplicity of environments, for each separate occupation has an E peculiar to it. It were a long task to tell in detail how the E's of particular occupations differ, but it will be readily granted that they do differ. Compare the surroundings of the soldier, sailor, scholar, peasant, miner, butcher. The great difference

of E in each of these cases is manifested by the special and peculiar way in which these several occupations mould the individual. Who cannot discriminate between a soldier, a sailor, or a butcher, and that not only by the outward moulding of the body, but, if opportunity for observation offers, by the inward and more subtle moulding of the mind? Now if we take E to represent the *entire* environment of any one of these occupations, and if the inter-action of S and this E result in health, the E of this occupation may be regarded as normal. A large number of occupations in civilized societies are necessarily injurious, and nothing could make them otherwise; indeed, it may be said of very many (I believe, of the majority), that they are *necessarily fatal*, if not always to the first generation, yet certainly to the second or third; and it would be well for us boldly to acknowledge the grim fact. Neglecting, however, those occupations in which S and E cannot, by any possibility, work healthily, and considering only such as are compatible with perfect health, we shall still find among individuals, who yet would be accounted healthy, a considerable difference as regards their normality to their respective E's. This occupation might especially suit one individual; that, another. An individual leading, as a brain worker, a comparatively sedentary life, attains, let us suppose, a ripe old age; but it is very possible that early death might have resulted if he had followed the laborious occupation of a navvy; and on the other hand, there may be many an old and healthy workman who would have died early had a sedentary, scholastic career fallen to his lot. The workman who attains a ripe old age might, for instance, under an inactive mode of life, develop kidney disease, while the brain-worker might suffer from aneurism or hernia had his life been one of muscular labour. Of course, there are many who, provided they observe the ordinary laws of hygiene, would reach old age in any occupation, but it is none the less true that individuals differ greatly in their power of living healthily in different employments, even though they studiously regulate their lives according to those laws.

What is true of the physical side is true also of the mental side of man. Many miss their vocation in life, and un-

happiness and failure result, while success and happiness might have been theirs had they chosen the right calling. In the former instance we may justly say that the mental S and the mental E are abnormal to one another; in the latter, normal.

The following passage from the pen of one who had a deep knowledge of human nature and its workings, so thoroughly embodies this idea that I venture to give it *in extenso* :—

"Some of my amiable readers, no doubt, are in the habit of visiting that famous garden in the Regent's Park, in which so many of our finned, feathered, and four-footed fellow-creatures are accommodated with board and lodging, in return for which they exhibit themselves for our instruction and amusement: and there, as a man's business and private thoughts follow him everywhere and mix themselves with all life and nature round about him, I found myself, whilst looking at some fish in the aquarium, still actually thinking of our friends the Virginians. One of the most beautiful motion-masters I ever beheld, sweeping through his green bath in harmonious curves, now turning his black glistening back to me, now exhibiting his fair white chest, in every movement active and graceful, turned out to be our old homely friend the flounder, whom we have all gobbled up out of his bath of water souchy at Greenwich, without having the slightest idea that he was a beauty.

"As is the race of man, so is the race of flounders. If you can but see the latter in his right element, you may view him agile, healthy and comely: put him out of his place, and behold his beauty is gone, his motions are disgraceful; he flaps the unfeeling ground ridiculously with his tail, and will presently gasp his feeble life out. Take him up tenderly, ere too late, and cast him into his native Thames again—— But stop: I believe there is a certain proverb about fish out of water, and that other profound naturalists have remarked on them before me. Now Harry Warrington had been floundering for ever so long a time past out of his proper element. As soon as he found it, health, strength, spirits, energy, returned to him, and with the tap of the epaulet on his shoulder he sprang up an altered being. He delighted in his new profession; he engaged in all its details, and mastered them with eagerness," &c.—*The Virginians*, Vol. II. chapter xviii.

This is one of many similar passages which might be taken from works of fiction, to show what the discernment of the

moralist sees to be the evil effects of incongruous, and the good effects of harmonious, surroundings.

It is not always easy to find out what walk in life will best accord with the mental proclivities. Some there are who will adapt themselves to any surroundings, and, like Mark Tapley, be happy anywhere and under any circumstances; others, again, will be always grumbling and unhappy, and these latter are abnormal, for no mental E admits of harmonious interaction with their mental S.

It happens occasionally that an individual will, from an early age, show a liking—nay, it may even be a passion—for a particular calling; such as the profession of engineering, arms, or music. In some of these cases the voice of inclination speaks with the loudness and wisdom of an instinct, and its promptings may safely be obeyed. More frequently, however, these early promptings are fallacious. How many children have expressed their determination to be engine-drivers or policemen! I remember one boy at school, who, when asked what he was going to be, always replied, "a philosopher;" and I may remark of him that he certainly gave promise of being no ordinary man, for in him was combined with very extraordinary mental powers, an innocence which was almost infantine.

Many young men are indifferent as to what profession or calling they follow, and leave others to choose for them; but when any special proclivity is displayed, it is not only unwise, but morally wrong, to thwart it; for by so doing we are shutting out the individual from that E to which he is by nature adapted, which is, in fact, normal to him. Let us not try to make a round peg fit a square hole.

That normality of S and E can only be considered in the relation of the one to the other is well shown by allowing individuals following very opposite kinds of employment to suddenly exchange places. Let, for instance, two healthy individuals, one a brain-worker, the other a muscle-worker, change places—a learned professor, let us say, with a navvy,—and it is quite needless to recount in detail the ill effect on each. We can imagine the evils which would result from the sudden strain on the heart and vascular apparatus of the one, and the multi-

tude of functional troubles which would be entailed upon the other, compelled, as he would be, to sit for hours together over a book! If he were a man of nervous temperament, he would probably go mad. Yet had these two individuals from the first followed each the other's occupation, it is very possible that each would have become adapted to it; and this leads to the distinction between actual and potential normality of S in relation to a particular E. By an "actual normality" of S, I mean existing normality of S, to a particular E—admitting, that is, of harmonious inter-action with it; by a "potential normality," a capacity to become normal to it. The process by which such normality is attained is none other than personal adaptation (= direct equilibration), so that, from the medical point of view, we may define personal adaptation or direct equilibration as that *process of structural alteration by which an organism becomes capable of living healthily in a particular E.* Perfect adaptation of S to E constitutes normality for both, and there is not normality of either until this occurs. During life there is a continual struggle towards a perfect adaptation of the S to the E by which it is surrounded, that is, the S is continually striving to become normal as regards its E, and this adaptation occurring during the brief span of human life is but a part of that grand scheme of adaptation which underlies the whole process of organic evolution.

Thus it is that a man who works chiefly with his brain, who uses his muscles but little, becomes gradually adapted to his mode of life—the muscular system, including the heart, sinks to the level of his inactive life, and the nutritive, nervous, and muscular systems all act in harmony. The change is a work of time. Few individuals take naturally to long hours of reading and muscular inactivity, and, indeed, all school work is for the most part forced; but by degrees the power of attention is acquired, till what was once effort becomes ease—nay, till what was at first, perhaps, actually injurious, becomes beneficial—till books and thoughts are as so much food for which the mind craves, and without which life were a misery. The individual, in short, grows into harmony with his surroundings: the S and E, at first abnormal, become normal. So again with the muscle-worker: his tissues,

by long exercise, are hardened and strengthened to work against gravity; the mind, never awakened into full activity, soon becomes adapted to the narrow world in which it lives, and is happy therein. What wonder, then, that if two such individuals could exchange places, there should be terrible commotion, and, it may be, actual disease!

In order to test the potential normality or adaptability of a particular S to a particular E, the exposure to that E should be as gradual as possible, to allow time for a gradual alteration to the structural state normal to it. By suddenly altering the E we do not test the potential normality, but the actual normality to it at the time of change. The truth of this is manifested in training for athletic feats. If a man who for many months has been sitting at a desk, suddenly attempts to climb a mountain 10,000 feet high, or to run 100 yards at full speed, nothing but disaster can result. Think of the sudden strain put upon the attenuated heart-walls and delicate valves! Put scientifically, the essence of training is the compelling the heart, valves, arteries, and muscular system to gradually undergo their maximum physiological hypertrophy.

And, indeed, to bring out the total potentiality of adaptability, much skill is required, and the physician is often called upon to exercise it. He, too, has to train the body; he has to modify the delicate S, to convert potential normality into actual, and thus, by a very careful process of education, to adapt a weak tissue to its E. Thus, a nervous system hereditarily weak may, by skilful treatment, be so strengthened during the period of development as to be rendered practically normal as regards an average external-body-E. Such training, however, requires the greatest skill, and we have probably not yet acquired a tithe of what we may one day hope to possess.

From the above considerations, it is clear that the whole question of normality turns upon the healthy inter-working of S and E—that health is the only real criterion of normality. Is an individual healthy? Then are his S and E both normal. But there is no fixed, unalterable standard of normality for either. Each can only be considered in relation to the other. Is there, then, no *proximate* standard? We may, in truth,

construct such a proximate standard, and it is more or less necessary to do so, but let it be borne in mind that it can be no more than a "proximate" standard. The simplest way to erect one will be by constructing a theoretical standard E; having done this, our task is completed, for a normal S may then be defined as one which interacts healthily with such a standard E. We might, indeed, attempt the definition of a normal S first; the standard E would then be one which would allow such a normal S to live healthily in it. But it is far easier to begin with the E, for, complex though it is, it is infinitely simpler than S.

We have seen that individuals differ enormously in their response to different modes of E. Now we can, in theory, so narrow the E as to exclude all that which is capable of working ill on any individuals, and to include only that which shall have a beneficial action on all. In order to do this we must contract it to the narrowest limits, including in it, indeed, only the positive essentials to life, such as food, warmth, air, and so forth, and excluding every non-essential. But, even with such restrictions, how are we to fix upon the standard diet, temperature, and atmospheric conditions? Different races, and, moreover, different individuals, differ much in respect of the kind of food best suited to them, and a like difference obtains in regard to climate. Wherefore this, our standard E, can be proximate only, and further, it is theoretic only: it would be quite impossible to obtain such an E.

Then as to S: as I have said, we may regard it as at least potentially normal if there exists anywhere an E in which healthful inter-action with it can take place. Thus, according to Salter, there is probably no case of true asthma but might be cured by residence in some particular part of the earth; hence, such a place must be regarded as normal to the asthmatically-inclined S, and the latter normal as regards it. It may be thought that it is absurd to regard an individual prone to asthma as structurally normal; but, if we push the matter to its logical conclusion, there is no escaping this result.

Nevertheless, for ordinary purposes, the best test of nor-

mality of S is the capacity of the S for living with a fair measure of health in an average E. It is, as a matter of fact, impossible to pass through life without being exposed over and over again to an E which is abnormal to the vast bulk of the community; every individual must be exposed to a certain quantity of "necessary mal-E," and in our conception of normality we must take into consideration the power of successfully battling against this—the quality (if I may so put it) of being affected in a small degree by it, or of readily recovering from the diseases which it causes. And here the element of constitutional vigour comes into consideration. If a weakly individual could live under a carefully regulated E to extreme old age, he would not, in the ordinary sense of the word, though yet he would in one sense, be regarded as a normal man, for he would be incapable of successfully battling against the "necessary mal-E"—against, namely, the average quantity of mal-E.

This leads us to consider an expression which is often used —"resistance to disease." During life the body possesses a power of resistance, "so that exposure to noxious agents of various kinds does not always, or usually, result in the manifestations of disease. In this way must be explained the escape of many from what must be regarded as very serious risks." In a limited sense, we are justified in speaking of "resistance" to disease; but if an individual continually escape unhurt by a so-called noxious agent, it is, perhaps, more correct to say that such an E is not abnormal to that individual. We should be no more justified in speaking of "resistance" in such a case than of endowing an ordinary individual with a resisting power to the asthma-exciting influence of ipecacuanha. When, however, a person in full bodily vigour is proof against the evil influence of a particular germ, but falls a ready prey thereto when exhausted from any cause, then we may conveniently speak of the natural vigour of the body affording resistance to the evil effects of the specific poison. Unless we are careful, however, this word "resistance" may lead us into error. Let us, for instance, consider the following remarks:—

"We are all of us habitually doing many things, living under

various conditions, not altogether good for us; yet, at least through a long series of years, if we do not trespass beyond certain limits, no apparent harm comes of it. And this should form part of the answer to be given to the very frequent inquiry whether this or that thing is *wholesome* or injurious. Many of these things are not strictly beneficial, but the contrary; and yet, in moderation, they may be indulged in, because, during life, there is a power in reserve which enables us to cope with these comparatively insignificant effects, and to overcome them again and again, without, for the most part, any permanent injury. Take the case of alcohol. It is difficult to show that there is any advantage whatever in its habitual use by a healthy man; and yet it is equally difficult, in most instances, to demonstrate any evil effect from moderate indulgence in it through lifetime. Or, take the instance of tobacco. . . . . That the influence of these habits is rather injurious than otherwise to most men, is suggested by the fact that when an effect appears at all it is usually on the side of evil. But the explanation of the impunity with which these and other practices are indulged in is probably to be found in the fact that, in most of us, there is a power in reserve—analogous, perhaps, to that of repair in the case of wound or injury—by which mischief is, in great degree, resisted or overcome. *Yet, withal, it must be borne in mind that various habits may work much evil in the long run, without the relation of cause to effect becoming at any time apparent.*"—Introduction to "The Book of Health," by W. S. Savory.

Here Mr. Savory assumes a power of reserve by virtue of which the body is capable of resisting more or less effectually certain nocuous influences. I am more inclined, however, to regard a particular agent as nocuous or innocuous in respect of a particular individual only. Mr. Savory assumes that alcohol and tobacco, even in small quantities, are injurious to every one, but that the body possesses a "reserve power" capable of fighting against their ill effects. According to my view, each man is a law in himself as regards the influence of any specific E—*e.g.*, alcohol and tobacco—upon him: a quantity of such E that to one might be injurious, might to another be quite harmless—nay, even beneficial. I say, the thing is either doing him injury, or it is not; and if it is not doing him injury, I see no occasion to call upon any *reserve power*. In those cases where alcohol and tobacco—notably the former—

are taken inordinately, it often happens that no ill effects are experienced at first; but this must not lead us to suppose that no harm is being done, and that a resisting power is all the time effectually combating the injurious influence. Suppose a healthy countryman comes up to London and works on the Underground Railway, it may be many years before any evil effect becomes manifest; the evil is, however, all along at work, silently and unperceived. The resistance is only apparent.

Hence, I maintain that if an individual has the power of resisting an agent which is universally regarded as nocuous, we are not justified in assuming a reserve power; it is better in such a case to look upon the individual as normal in regard to that particular agent. Were the capacity of being unharmed by such nocuous agents in all cases in direct proportion to bodily vigour, then, perhaps, it would be convenient to speak of a reserve power, but this is not the case, for a sickly individual may be less susceptible to a particular nocuous agent than one of extraordinary vigour, and one cannot suppose such a person to possess a resisting power in the shape of excess of health, as Mr. Savory apparently assumes. The explanation is rather this: what is normal to the one is abnormal to the other.

CHAPTER III.

To what extent Structural Abnormality occurs during the Actual Time of Disease.

WE have seen that it is by no means easy to say offhand what constitutes normality of structure. Although it is impossible to fix any criterion of abnormality available for all, it is nevertheless convenient to have some sort of criterion, otherwise it would often be impossible to say of any given structure that it was abnormal, for we could never be certain that there might not be an E somewhere in which that S could carry on its functions normally.

There are two tests whereby to judge of the abnormality. The first is *examination of the structure* either with the naked eye or by the aid of the microscope. We are in this way able to discover certain structural states which our knowledge of normal anatomy, macroscopic and microscopic, tells us are abnormal beyond any doubt. The criterion here is experience. We should not be justified in regarding any structural appearance as abnormal unless it differed beyond all manner of doubt from the condition obtaining in the vast majority of ordinary healthy human beings.

But although by the examination of a tissue we can, in many instances, pronounce it to be abnormal beyond all question, we cannot, conversely, be certain that it is normal if we fail to detect structural alterations, for the tissue may be the seat of some subtle structural change altogether beyond the reach of discovery. These remarks apply more particularly to nerve centres, in which the finest shades of structural change may mean all the difference between perfect health and serious disease. They do not apply with equal force to the cruder tissues—such, for instance, as the connective tissues. If a practised observer fails to detect altered structure in these, we

may almost certainly conclude that there is no abnormality; and the same may, perhaps, be said of most of the glands. I suppose, for instance, that, given a perfectly healthy liver, a skilled observer could with certainty pronounce it to be such.

A second test remains to us—viz., *functional efficiency*. This, as we saw in the last chapter, is the great criterion of normality. We ask ourselves: Do the tissues carry on their functions properly? But if we wish to obtain a criterion of normality for S it is obvious that we must qualify the question, seeing that individuals differ in respect to different E's. We must ask: Do the tissues carry on their functions properly when the body is subjected to a standard normal E? We saw, however, that it is no easy matter to determine such a standard; that in endeavouring to erect a standard E, the only plan open to us is to exclude all those forms of E to which different individuals respond very differently, such as the ague poison and extremes of temperature, and to include the bare essentials to life, such as food, air, certain temperature, and exercise. Given such a standard environment, the functional test may be expressed as follows:—*If the tissues of the body do not carry on their functions properly under this standard E, there must be distinct abnormality of structure.**

These two methods—*i.e.*, the method of direct examination of the tissues, and that founded on the observation of functional efficiency—*together* afford the most perfect test of structural abnormality at our disposal.

But although this double method is the most perfect of which the circumstances of the case allow, it has its imperfections. As regards the method by examination, it is for the most part available only after death, and even then an abnormality of tissue may escape our most diligent search. And as regards the observation of functional efficiency, it, on the other hand, is obviously one that can only be applied during life, when it is no easy matter, as we saw in the last chapter, to be absolutely certain that the functions of an organ are going on perfectly; as a matter of fact, the most serious structural disease may, quite unknown to us, lurk in an individual, for

* These remarks are subject to the qualifications contained in the last chapter.

we often discover in the cadaver marked structural abnormality, to say nothing of minor structural abnormalities, such as small atheromatous patches, which may give no evidence of their existence during life by altered function. I shall presently discuss the question whether we are justified in regarding all such minor structural changes as distinct abnormalities.

Having, then, in the above tests, a means whereby an approximate criterion of abnormality may be obtained, let us now inquire how far structural abnormality occurs during actual disease.

It has been over and over again remarked that disease may result from abnormality of S, abnormality of E, or abnormality of both. Given any of these, an abnormal inter-action must ensue. When the E alone is abnormal, we theoretically assume the S to be normal—that is, normal when the abnormal E first acts upon it; the propositions take no account of the condition of the S during the abnormal inter-action—whether or not, namely, it retains its normal structure.

In respect of this question, we may divide diseases into two classes:—

1. Diseases accompanied by obvious structural abnormality of tissue, as determined by macro- or microscopic examination.

2. Diseases in which there is no discoverable abnormality of tissue.

This latter class falls into two subdivisions:—

a. Diseases in which the S acted upon is normal at the time the nocuous E acts upon it, as may happen, for instance, in poisoning by opium and in indigestion from a gross error in diet. The E in such cases is for the *most part* a necessarily mal-E—that is, one which would produce an injurious effect upon all. (I say, for the *most part*, because individuals differ in their response to poisons and indigestible articles of food.)

b. Diseases in which the S is abnormal at the time the nocuous E acts upon it, as epilepsy, insanity. In these cases the E calling out the disease need not be a necessarily mal-E.

Let us now consider each of these three classes separately.

1. *Diseases in which there is obvious Structural Abnormality.*—As an example of these we may instance the inflammations which play such a large part in disease. In these cases the E acting upon the S produces obvious abnormality in structure. Such a pronounced structural change implies disease, but it must be carefully borne in mind that a distinct and marked structural abnormality may exist without giving rise to any symptoms—to wit, patches of atheroma, miliary aneurisms, deep-seated tumours, and many other gross structural changes. It would be a great mistake to suppose that disease necessarily exhibits symptoms, or that the presence of these is the test and criterion of disease. The symptoms of disease are only the evidence of it to be got during life, whether by altered function or otherwise, and that evidence may not be forthcoming; and this for two reasons—first, because it is sometimes from its very nature undiscoverable (as may happen in atheroma); and secondly, because of failure on our part to detect the discoverable—*i.e.*, that which by a fuller development of human resource might be discovered.

Be it noted, in respect of such non-symptomatic disorders, that the potential germ of symptomatic disturbance resides within them, and further that all such cases are covered by the definition of disease already given—viz., that it is abnormal inter-action between S and E. These non-symptomatic disorders are in a large measure localized—that is, they lead to a very slight secondary mal-E. In the site of an atheromatous patch an abnormal inter-action between S and E has been going on from the earliest date of the disease. It might be urged that an atheromatous patch, when it arrives at its final stage of calcification, would not, according to this definition, constitute disease, seeing that little or no *inter-action* of S and E would then be taking place. This is, however, no cogent objection, for it is evident that there is not taking place in the particular part of the body where the patch is located that inter-action of cell and cell-E which constitutes health. It is quite obvious that, if there is no inter-action at all, there is interference with proper inter-action.

If, however, exception be taken to this mode of argument,

then it may be pointed out that, even supposing no abnormal inter-action is taking place in the atheromatous patch, this latter may lead to abnormal inter-action elsewhere, by interfering, for instance, with proper vasomotor action, and thus it still will constitute disease as above defined; but if it be further urged that not only need there be no abnormal inter-action between cell and cell-E in the atheromatous patch, but that no secondary trouble need follow in other parts, then I reply that such an atheromatous patch cannot constitute *actual disease*; and, if this be true, it follows that *there may be distinct abnormality of structure without actual disease.* All will acknowledge that this is true of mere anatomical curiosities, such as horse-shoe kidneys and supernumerary digits; but if our definition of disease is accepted it is also true of other structural abnormalities which do not fall under the category of mere curiosities, such, for instance, as cases of dried-up abscesses and fatty tumours, which interfere in no way with the functional efficiency of the tissues. There is ample scope here for scholastic discussion, but there is no occasion to pursue the subject further.

2. *Diseases in which there is no Discoverable Abnormality of Structure.*—Such diseases are frequently styled "functional" diseases. A functional disease may therefore be defined as one in which no lesion is discoverable as a cause.

We shall have presently to inquire whether, in such functional disorders, there is necessarily structural change; meanwhile, there is something to be said about this term *functional* as applied to disease. It is clearly a bad term, since alteration in function is not peculiar to disease unaccompanied by obvious structural change; it very rarely happens that any gross structural change is unattended by disordered function. In some few cases, such as those cited above, of dried-up abscess, fatty tumour, and such like, there may be no functional abnormality, but this is very exceptional, for even if no symptoms are forthcoming—no evidence of the disorder during life, whether in the shape of altered function or otherwise—this does not show that there is actually no alteration of function. I hold that in almost all cases of gross structural change there actually is a modification of function; but whether this

is so or not clearly depends upon the meaning we set upon the word *function.*

The term *Function* is familiarly used to designate some obvious purpose which a structure fulfils. Thus, we say the function of a muscle is to contract; of a gland, to secrete; of a nerve-centre, to start or modify nervous impulses; of connective-tissue, to bind together the elements of the tissues; of a blood-vessel, to conduct blood. Now, using the term in this sense, it is obvious that we must make a distinction between the active functional state of which the first three instances afford examples, and the mere passivity of which the last two are examples. It will be quite unnecessary to say anything further of this latter kind of function; but it is necessary to say something of the former kind. Still using the word function in the sense indicated—*i.e.*, to designate some obvious purpose which a tissue fulfils—we may define the active function of a tissue as that part of its activity which is not necessary to its own vitality, but is displayed for the benefit of the organism at large. Thus we may regard the secretion of bile by the liver-cells as apart from and independent of the nutrition or vital process of the liver-cell: according to this view, the liver-cell is a machine for the elaboration of bile out of certain crude materials brought to it, and the process of bile manufacture is something quite distinct from the vital process of the machine or cell itself. In a similar way we may regard a muscle-cell as a machine for getting force out of the food materials supplied to it, the process by which the machine is kept alive constituting its nutrition, that by which it converts insensible into sensible motion constituting its function.

How far we are justified in thus sharply separating nutrition and function it is difficult to decide. According to the older views, such functional exercise was the outcome of actual protoplasmic break-down—*e.g.*, the force spent in muscular contraction was, it was thought, the result of an equivalent break-down or destruction of muscle-tissue, and the secretion of a gland-cell was supposed to take place at the expense of actual protoplasmic destruction. Now, if this view be correct, it follows that "function" in the sense here used is part and parcel of the nutrition of the cell, or, at all events, it cannot

be separated from it. The term nutrition would more particularly refer to the building-up, as distinguished from the breaking-down, of the cell, to construction as against destruction (the latter constituting 'function'), but each process would be essentially bound up with the vitality of the cells. According to the later view, the muscle-cell elaborates muscle-dynamite or inogen, the gland-cells elaborate zymogens, and both are independent of and distinct from the actual fabric of muscle or gland-cells.

Which of these views is correct, or if either, I cannot tell; but this much may be said, that it is certainly convenient to separate the nutrition or vital process of the cell from its function, using the latter term as indicated. We can then explain functional errors by imperfect nutrition of cells, without presupposing any actual structural change, for, if the nutritive processes of the cell fabric do not go on properly, the latter will not be able to perform its functions properly. I confess, however, that I am not at all certain that we are justified in making this distinction between nutrition and function, except for purposes of convenience. And I have somewhat enlarged upon the subject in order that the reader may henceforth attach some definite meaning to the word function, as used in the physiological sense, for I have nowhere been able to find any intelligible definition of it.

It may be asked: What is the meaning of "function" as applied to a unicellular organism? It seems to me that it here simply refers to the vital processes of the organism. But in a multicellular organism some one cell-capacity is exceedingly developed, or there is an evolution of some new property which is not actually necessary to the life of the cell, but serves some purpose in the general economy of the organism, and it is convenient to speak of this as the function of the cell.

Viewed thus from the point of view of evolution, it is, in a manner of speaking, impossible to separate such special property from the vital process of the cell, for it has become through long practice part and parcel of cell vitality—so much so that if the cell were not to exercise its "function," atrophy or degeneration would ensue. It is very probable, for instance, that if the liver-cells ceased to secrete bile, they would

degenerate; if they did not, we should, indeed, have the strongest possible justification for making the distinction between function and nutrition. It is certain that if a muscle remains inactive for some time degeneration ensues, but this may be due to the mechanical effect of muscular contraction on the circulation in the blood-vessels and lymphatics through the substance of the muscle.

With these remarks on function, let us proceed to consider the part which abnormality of structure plays in the so-called functional disorders.

a. Functional disorders, in which the S remains normal when the nocuous E operates upon it.—I will give two instances of this kind of disorder. A healthy person takes an indigestible meal and suffers from dyspepsia; or, again, he is poisoned by opium, and in both cases perfect recovery ensues upon removal of the nocuous E. The fact that rapid recovery occurs when the hurtful E is removed—that is to say, after the poison has been eliminated from the body and the indigestible matter disposed of—is sufficient proof that these disorders are functional. No one would for a moment contend that there is any gross structural change in either of them. But the question we have now to ask is, does any undiscoverable structural alteration attend these disorders? An abnormal E necessarily leads to disordered inter-action of S and E, but does it necessarily lead to an abnormal disposition of the cell particles, or of the cells among themselves? If it does, this much at least is certain: the change must be a temporary one, for there is rapid return to health after the removal of the nocuous agent.

If the disorder continues for some time after the complete removal of the nocuous E, we are justified in assuming abnormality of structure, as I shall presently show; but in the cases mentioned there is no such continuance of disease-action. And here we are met with the old difficulty—what constitutes normality of cell-structure? If the structural state of the cerebral cortex which accompanies pain be considered abnormal, we must obviously predicate a lesion for painful dyspepsia; and in opium poisoning we are compelled, I think, to conclude that there is an actual deviation from normality

in certain cell-structures. In this case, all the positive conditions of healthful cell action (I allude to the tissues primarily and chiefly affected by the drug) such as the presence of oxygen, food-stuffs, &c., obtain; therefore, the opium must render the S abnormal, otherwise the proper inter-action would occur. The only alternative supposition is that the drug so acts upon the cell-E as to render the positive conditions imperfect. This, indeed, occurs in some poisons—*e.g.*, CO, which seizes upon the O needful for the tissues. All those poisons which do not modify the E so as to render the positive conditions imperfect, must react upon the cell and modify its molecular structure, in such a way as to prevent the proper inter-action of S and E. It is obvious, however, that when rapid recovery occurs, this molecular dislocation cannot be very serious, and hence we may practically disregard the existence of structural change in this class of malady. But if, on the other hand, the administration of a poison be persisted in for a long time, or any habit capable of producing functional disorder be systematically indulged, it is well known that permanent structural alteration may ensue; and this fact suggests that some structural alteration must attend even a temporary functional disorder.

A large number of the functional disturbances which occur in what may be called the genuinely structural diseases would, considered by themselves, come under the class of disorders we are now considering, such functional disturbances being caused by secondary mal-E. The faintness in aortic regurgitation from the irregular supply of blood to the brain affords an example. Often the secondary mal-E consists of a poison, as in Bright's disease, and I have already had occasion to allude to the profound structural changes and fatal consequences directly traceable in this disorder to the retention of nitrogenous excreta in the blood.

b. Diseases in which the S is abnormal when the E operates upon it.—It is these disorders to which the term "Functional Disease" is more commonly applied. The so-called "neuroses" afford the best example of this class. If an individual is exposed to an averagely healthy E and develops one of the neuroses, there must be a structural deficiency in some part of the

nervous system, for E being normal, and disease depending upon an inter-action of S and E, S must be abnormal.

In such cases the structurally deficient tissue may be limited, and the abnormality may possibly be so subtle as to be absolutely undiscoverable, but structural abnormality there certainly is. This, it is obvious, from the definition of structure already given, may consist in peculiarity in respect of—*a*, the arrangement of the atoms into molecules; *b*, the disposition of these latter among themselves; *c*, the mutual arrangement of the individual cells into tissues; and, finally, *d*, the mutual connection of physiologically distinct tissues. Thus, in normal nerve centres there must not only be a proper structure of individual cells, but also a proper connection of these by processes, or what not, into individual centres, and, further, a proper connection between the individual centres themselves. We can well understand how a nervous system might be deficient in one of these particulars without our being able to detect the deficiency by the most elaborate search.

A deficiency in any one or other of them constitutes the *lesion* in this class of functional diseases, and it exists before the actual disease is present. The exciting cause of these *pure* neuroses leads to an exaggeration of the abnormality, and the weakness is then suddenly revealed. This *sudden* increase of abnormality is certainly of the nature of molecular change; its very suddenness, as well as the character of the exciting cause—*e.g.*, strong emotion (which may set up epilepsy, hysteria, neuralgia, or chorea), proves this. A sudden emotion cannot induce alteration in the connections of cell with cell, or centre with centre; it can only lead to an atomic or molecular commotion. In these cases the centres immediately affected may be very limited, but eventually, owing to the mutual connection of tissue with tissue, a large portion of the nervous system may become involved.

It is worthy of note that the neurosis thus suddenly induced may last a long time; indeed, its effects may not wear off for months. Seeing that disease = an abnormal inter-action between S and E, it is conceivable that its continuance might be due to a continuously-operating mal-E, the abnormality of S

being in no way heightened; but when the exciting cause is some shock, sudden, or even, it may be, instantaneous, it cannot be the mal-E which sustains it. It must, therefore, be kept up by some permanent alteration of S, and we have thus actual proof of the important part which mere atomic or molecular alterations play in disease.

The fact that disease is self-sustaining—that it continues after removal of the exciting cause—is conclusive proof that there is a more or less permanent alteration in some tissue or tissues. Hence, the great test of the existence of a purely functional lesion is to ascertain whether or not the disease continues after the removal of the exciting cause and under a perfect system of hygiene. If it does continue, there must be some more or less permanent abnormality of S, and the disease is not purely functional; but if it does not, it does not follow that there is no structural alteration whatever, for there may be a temporary imperfection in cell structure, as in opium poisoning or in profound exhaustion. When, however, the functional disturbance is only temporary, we may, as already observed, disregard the change in S.

Let us take an example. A man is so over-worked and jaded that he can do nothing for himself. He is suffering from functional disease, and few would doubt that in such a case there is serious molecular alteration in some of the nervous tissues; but after a few hours' rest and proper food complete recovery occurs. In such a case the alteration has been very temporary, and one cannot designate it a lesion, seeing that the centres have the power of reverting almost at once to their proper state if they be allowed a fair chance. But if this over-work be continued for a long period, the centres may get into a condition which is not curable by a few hours' rest and proper food; months of most careful treatment, entire cessation of work, change of scene, and so forth, may be needful to effect recovery; nay, so serious may the disturbance be, that complete recovery will not occur under the most favourable conditions. Here, then, we have to deal with a distinct *lesion*, undiscoverable indeed, but nevertheless there.

I have spoken much of nerve centres, as though they constitute the tissues chiefly affected in functional disorders, and this

is indeed the truth. So far as I know, all the purely functional diseases included in Class *b* originate in such a lesion of the nerve centres, for these structures have under their immediate control the entire working of the body. If an organ presents no obvious lesion, we may safely reckon upon its healthy action, provided its nervous apparatus be efficient. On the other hand, an undiscoverable lesion of this or that nerve-centre may profoundly modify the E of any cell in the body, and may give rise to symptoms referable to any organ which it governs, be it heart, lungs, stomach, muscle, or any other.

CHAPTER IV.

The Advantage of Changed Conditions of Life upon the Vital Organism.

It is a well-established fact that, within certain limits, changed conditions of life are beneficial to both the plant and animal organism. This fact has long been known to horticulturists and breeders of animals. In order to obtain the best results, the horticulturist takes care to vary continually the soil of the successive generations of a plant, and breeders of animals are equally careful not to confine several successive generations of the same breed to a narrow and fixed locality.*

How are we to explain the beneficial effects thus obtained?

According to Herbert Spencer, the forces of Nature are ever working towards an equilibrium. Thus, when a fire burns, the tendency is towards the arrangement of atoms in their most stable form. In like manner the aggregated forces constituting a living organism tend to fall into a state of stable equilibrium. Such a condition is, however, inconsistent with vital activity, in which the acting forces, far from being stable, are undergoing incessant change. By change of E, a new series of force is introduced, so that the approach towards equilibrium is for the time checked, and this has a beneficial effect upon the body processes.

Darwin explains the beneficial effects of changed conditions of life in a very similar way, and he believes that the necessity for sexual reproduction admits of a like interpretation. We have seen that the whole purpose of sexual reproduction is to secure the union of two unlike individuals. Such a union, according to Darwin, tends, by a disturbance of forces, to check the progress towards equilibrium, in the same manner as changed conditions of life; for when the germ and sperm

* See on this subject Darwin, "Variation under Domestication," Vol. II. Chap. xviii.

come from unlike individuals, there is a struggle of opposing tendencies.

Wherefore two important facts regarding man stand out prominently, viz.:—

1. That advantage accrues from change of E from time to time.

2. That advantage accrues from the marriage of unlike individuals.

The above considerations explain the good effects of "sending a patient away." I have been accustomed to associate the benefit derived from this course with the habit of primeval man to wander about from place to place. Our ancestors were nomadic probably for many thousands of generations, and the wandering instinct is even now strong among us, so that the human organism is still more or less adapted to a continual change of locality, and at times actually craves it. But this explanation, though probably correct *so far as it goes*, is only partial. That offered by Spencer and Darwin goes far beyond it, for it approximates to an *ultimate explanation*—to an explanation, *i.e.*, which does not leave anything further to be explained, cannot be rendered plainer, cannot be referred to any more general principle.

It is not only in respect of climate that "change" is beneficial to man. Within proper limits it does good in many ways. See what a potent influence it has upon the mind! Most people sooner or later find out for themselves that the great secret of enjoyment lies in continual mental change—not necessarily in change between very many things, but in, at all events, change from one thing to something else.* Indeed, the mind even more perhaps than the body craves for variety. This is, at any rate, true of the cultured mind, though the desired change is not necessarily change of scene. The man of culture does not need to change his locality in order to get mental variety: he has never-failing sources of mental diversion in his library, in his acquaintances, in the world around him. But although the mind can thus, as it were, create its

* In reference to the subject of change as a necessary factor in mental processes, see Bain's "Law of Relativity:" Mental and Moral Science. Alexander Bain, p. 83.

own diversion, such change does not work the same exhilarating effect upon it as diversity of external surroundings. It is better that the change should strike through the senses; and there can be no doubt that the good effect of travel upon health is in very large measure due to change of scene, social surroundings, and general mode of life. Reading, to take the commonest form of mental diversion, is essentially a subjective process; when occupied with it, the mind is largely bent in upon itself; the thoughts do not actively go out to surrounding objects. It is true that by many kinds of reading the individual is to a large extent drawn out of himself, but by no means to the same extent as by actual observation of the outer world. But if his surroundings are quite new, and at the same time capable of commanding his rapt attention, then indeed he becomes self-forgetful, and has little opportunity to harbour gloomy thoughts, which depress the vital processes and retard recovery. It is very remarkable what a potent influence the mind has upon the body. A careful study of Dr. Tuke's book on this subject will bring this truth forcibly home to the reader. There are many ways of influencing mind; but when our object is to draw the individual out of himself, there is no method so effectual as that of sending him away from home, and, by so doing, diverting the current of his thoughts out of the channel in which they have too long stagnated. The altered mental state that rapidly ensues reacts upon the body; there is increase of appetite, a quickening of the circulation, better sleep, a rapid improvement in general bodily health. No doubt such improvement is due in large measure to the direct effect of changed locality upon the body; nevertheless, all will allow that the mental effect of the altered surroundings often plays a very considerable—in some cases the chief—share in the process, and it is indeed very remarkable that those subtle cortical changes which are the concomitants of thought should be capable of working such marked effect upon the body—turning the balance, it may be, in favour of Life or Death!

CHAPTER V.

Heredity.

I now propose to make some further remarks on the subject of heredity, as we are in a position to form a just estimate of the extent of its influence in the causation of disease.

There can be no doubt—and I say this emphatically—that pathologists do not sufficiently recognize the important part played by heredity in disease. Yet mankind in general, without seeking for the why or the wherefore, tacitly acknowledges its potent influence in determining the conformation of mind and body. In respect of the latter, it has been recognized by breeders of animals, as Darwin is so careful to insist, since time immemorial; and as regards its influence on the mental portion of our being, we have only to study biographies and works of fiction to see how well the writers have understood its significance.

In nothing, perhaps, is the influence of heredity more manifest than in the evolution of the moral faculty, and this branch of the subject has been thoroughly discussed by Herbert Spencer, who demonstrates how the finer shades of moral faculty have been, and are now being, evolved. Man being a social animal, it is necessary for him to observe certain rules of conduct towards his fellows. If lying and theft are accepted practices, no social community can exist, except in an inchoate condition; therefore, the social community of which man forms part must be bound together by certain ties of mutual conduct, such ties constituting "a code of morality." Generation after generation of men being thus compelled to observe certain rules of conduct towards one another, the moral faculty gradually rises into being: it begins to exist, that is to say, independently of inculcation, although, of course, capable of being strengthened and

developed thereby. We first find it existing among the different members of a family—notably, between mother and child, in the form of instinctive affection; then among the different members of a tribe, taking the form of crude laws; and, finally, among the different members of a nation. But what is noticeable is that, at first, there is no sense of any obligation extending beyond these comparatively narrow limits; there is no recognition of the moral tie between family and family, tribe and tribe, nation and nation. A certain code of morality among the individuals of each of these aggregations is absolutely necessary to its separate existence, but it is not equally necessary that any morality should exist between the separate aggregations themselves. Hence we often find it altogether absent, and perpetual warfare going on between them. But just as families have united to form tribes, and tribes to form nations, and these again to form larger nations, so, in course of time, we may look for the latter uniting to form one vast federation; and then, but not till then, the obligations always existing between the communities into which mankind naturally falls, will be recognized, and warfare cease. Thus, the conduct of individuals towards one another must become more and more exact as civilization advances, and since the moral principles thus inculcated from generation to generation leave upon the mental organization an actual impress which tends to be inherited, it follows that with progressive civilization the moral faculty grows stronger and stronger.

Such an evolution of morality rests upon the principle of heredity. It assumes the capacity of heredity to transmit fine shades of mental alteration, and this capacity has been, as I observed just now, long recognized by biographers and writers of fiction. Mr. Henry Drummond points out how careful the former are to study in detail the working of hereditary influence. "Students of biography," says he, "will observe that in all well-written lives attention is concentrated for the first few chapters upon two points. We are first introduced to the family to which the subject of the memoir belonged. The grand-parents, or even the most remote ancestors, are briefly sketched, and their chief characteristics brought

prominently into view. Then the parents themselves are photographed in detail: their appearance and physique, their character, their disposition, their mental qualities, are set before us in critical analysis; and, finally, we are asked to observe how much the father and mother respectively have transmitted of their peculiar nature to their offspring—how faithfully the ancestral lines have met in the latest product; how mysteriously the joint characteristics of the body and mind have blended, and how unexpected, yet how entirely natural, a combination is the result. These points are elaborated with cumulative effect until we realize at last how little we are dealing with an independent unit, and how much with a survival and reorganization of what seemed buried in the grave." Here the influence of heredity upon the conformation of both mind and body is recognized. Mr. Drummond then continues: "In the second place, we are invited to consider mere external influences (=E)—schools and schoolmasters, neighbours, home, pecuniary circumstances, scenery, and, by and by, the religious and political atmosphere of the time. These, also, we are assured, have played their part in making the individual what he is; we can estimate these early influences in any particular case with but small imagination if we fail to see how powerfully they have moulded mind and character, and in what subtle manner they have determined the character of the future life." Mr. Drummond, be it noted, speaks only of the mental E, for a biographer treats essentially of the mental, and only by the way, as it were, of the physical, man. Innumerable illustrations of this method might be given. The following will suffice. The subject is Abraham Lincoln:—"He seldom spoke of his early life, or of his parents; but the researches of some of his biographers have *indicated the hereditary sources of his chief characteristics.** We know that the grandfather was a vigorous backwoodsman, who died a violent death; that his uncle was a grim and determined man-slayer, carrying out for years the blood feud provoked by the murder of his parent; that his mother was habitually depressed; and that his father was a favourite of both men and women, though a mere savage when irritated, fond of fun, an endless story-teller, physically

* The italics are mine.

powerful, and hating hard work. *Out of these preceding traits* it is not difficult to imagine how the great Abraham came to be inflexible of purpose and strong of will, though indolent —why he was good-natured to excess in his excess of strength —and why he was a great humourist, and, at the same time, a melancholy man." Having thus traced the hereditary influence, the writer proceeds to consider the influence of the E. How often, I would ask, does the pathologist, when investigating the influence of heredity in disease, in the same way try to analyse minutely the several ancestral traits? It must be acknowledged that it is very seldom. His task, I admit, is much more difficult, for while the mental traits of an individual are obvious, being, so to speak, on the surface, the same cannot be said of the minute structural characteristics of his several tissues; but difficulties should not deter from a task when great issues are at stake.

Writers of fiction are equally ready to recognize the influence of heredity. George Eliot, describing Adam Bede, writes: "He was not an average man; yet such men as he are reared, here and there, in every generation of our peasant artisans, with an inheritance of affections nurtured by a simple family life of common need and common industry, and an inheritance of faculties trained in skilful, courageous labour."

Seeing, therefore, how thoroughly the influence of heredity upon the mental organization has been recognized by those whose close study of human nature entitles them to speak with authority, it scarcely needed the work of Galton to prove the inheritability of genius. (I say this with no want of appreciation of his most interesting book.)

To turn now to the physical side, the prominent part played by heredity in the causation of disease will be at once evident if we bear in mind that disease is a *morbid inter-action of S and E*, and that S is determined almost entirely by heredity. Strictly speaking, every disease from which an individual suffers is hereditary. Although this may seem to be an exaggeration, the truth of it will presently be apparent.

We have seen that the offspring is in a large degree the resultant of many ancestral tendencies, and that, could we only

guarantee an equality of E, all brothers and sisters would, save for sexual differences, be exactly alike. All other differences are, as we have seen, due to differences of E, for E is capable of modifying S. Let the letter S stand for the structural mean to which the sons or the daughters of any given couple tend, and let s_1, s_2, and s_3 represent the alterations which the different E's work upon this S; then Ss_1, Ss_2, Ss_3 will represent the structure of the several children.

Although it is convenient to speak of an inherited structural mean, such a mean is, be it remembered, entirely ideal, since it assumes an ideal E, and one which it would be impossible to define scientifically. In attempting the definition of such an ideal E, all one can say is that it should be as negative as possible—one, namely, tending to alter the S in as slight a degree as possible.

The formulæ Ss_1, Ss_2, &c., represent the actual structure of any individual at any particular period of life—S representing that part of an individual which is the direct outcome of heredity, and s, such modification in it as has been brought about by E. Now it is important to observe that the nature of s is very largely dependent upon the nature of S; I have already remarked how particular Darwin was to emphasise the fact that a variation depends more upon S than upon E; and inasmuch as S, or the structural mean, is strictly the outcome of heredity, we see what an enormous part heredity plays in determining Ss, or the actual structure at any given time.

Disease being the abnormal inter-action of the individual and his E, it follows that $Ss + E$ will express the causation of any particular disease. Now the nature of Ss determines whether or not it shall respond pathologically to a particular E, and therefore heredity must play a large part in the causation of every disease. Let me illustrate this by a very simple example. The diversity of diseases among different species of animals depends of course very largely upon differences of E—for, as we have seen, every species has its own specific form of E; but the chief cause of the diversity is certainly difference of structure. Thus, a child and a dog are exposed to a distemper-giving E: the one contracts the malady, the other escapes. This difference of response is obviously due to differences in

the Ss; and since, as we have seen, the Ss is almost entirely the outcome of heredity, it follows that heredity determines the disease in the dog. Again, let each be exposed to the virus of measles: the child will this time contract the disease, while the dog will escape; and here again the character of the response is determined by heredity.

Some may doubt the legitimacy of the above implication, namely, that measles is hereditary. It is, however, allowed on all hands that a special tendency to contract the different specific fevers displays itself in particular families, and does anyone doubt that this excessive proclivity is inherited? The above argument, I think, renders it clear that *all* cases of specific fever are hereditary in the strictest sense of the word; and if it be thought that this view requires further justification, let the reader compare any specific fever, say measles, with tubercle. None will deny that tubercle is hereditary, but how? The answer is, by an inheritance of a peculiar structure (or soil) favourable to the development of the tubercular bacillus; but let the specific pathogenic E be what it may, there can be no doubt that a peculiar S is necessary, and that this peculiarity is inherited. Exactly the same line of argument applies, of course, to measles.

So much for the influence of heredity in the production of the specific fevers. There are probably few who will not acknowledge this influence; but will they so readily allow that such a disorder as flea-bite has quite as much of the hereditary element in it as phthisis? There is, however, no escape from this conclusion. Some persons, if exposed to the attack of fleas, are furiously bitten, and suffer the direst inconvenience, while others wholly escape, or, if bitten, suffer little or no discomfort. There is, in fact, a very great difference between different races and different individuals in respect of the tendency to be attacked by the different parasites, microscopic or macroscopic; and these differences are due to Ss, which, as we have seen, is almost entirely the work of heredity. But if the element of heredity in such disorders is apt to be lost sight of, how much more likely is it to be overlooked in *traumatic injuries?* In such injuries the cause resides chiefly in the E, of which the chief element in

this case is violence. How, then, it is asked, can heredity play a part in the production of injuries? I reply, through the power of S to modify E by means of *mind*. If an individual places himself in the way of receiving injury, then S must have much to do with the causation, since it is the S that in this case determines the E. If the injury be such as it would have been impossible for the individual to avert, it may be regarded as purely accidental; but if it be due to carelessness or recklessness, or love of adventure, the S must be held largely responsible for the injury; and all the various mental characteristics are inherited.* Suppose, therefore, an individual, through utter carelessness on his part, sustains a fractured skull—say, from a falling brick-bat—such injury must, if the carelessness be inherited, which it often is, be allowed to be an inherited disease. Similarly, an individual may be seriously injured in the hunting field, and if this be due to an inherited recklessness, such injury will be clearly inherited also. The remark applies equally to such a case as that of that brilliant soldier, Colonel Burnaby, who, impelled by a love of danger and a dauntless courage, courted death upon the battle-field; indeed, the very virtue of a man may tend to his death, as it did with the martyrs of old and with the hero Gordon. But do love of danger, courage, or other virtue arise spontaneously, and independently of heredity?

Whenever, therefore, an individual suffers disease through imperfect regulation of his E, and this imperfect regulation is the result of some peculiar inherited mental organization, that disease is emphatically inherited. We have already seen that man is to a large extent the controller of his destiny. His power of control lies, of course, in his S, and if the control be defective, the defect is in the S. Such defective control may lead to multitudinous disasters, for a man can wreck his constitution in a thousand and one ways. As civilization advances the E of man becomes more and more complex, and greater skill is needed in order to regulate it properly. Causes of disease are multiplied. Unfortunately, over a large number of these the individual has no control, as, for instance, over

* Herbert Spencer remarks, "Awkwardness is continually entailing injuries and death" ("Principles of Biology," Vol. II. p. 496).

the mal-E attaching to many occupations, and in such cases S is in no way responsible for the mal-E; nevertheless, there are manifold mal-E's at hand, which the individual may court or shun at his pleasure, such as drink and other excesses; and the tendency to indulge in these is inherited. It is generally acknowledged, for instance, that such is the case with intemperance; and thus a man may inherit cirrhosis of the liver, not through any very special tendency of that organ to undergo morbid change, but through an inherited tendency on his part to expose himself to an E which has the power of calling forth this particular disease.

Let us now inquire into some of the reasons which have led medical men to under-estimate the share taken by heredity in the causation of disease.

1. It is quite obvious from the above remarks that an individual may suffer from a hereditary disease, even though none of his progenitors have ever contracted it. We have seen that measles is quite as hereditary as phthisis; but there are, I take it, isolated tribes of men existing in remote corners of the earth where the measles bacillus has never spread, who yet would be highly susceptible to the poison if exposed to it.* Such would, if attacked, inherit the disease in the strictest sense, notwithstanding the immunity of their ancestors. From this conclusion there is no escape if we grant that the inheritance in measles, as in tubercle, is an inheritance of soil, for exactly the same argument applies to tubercle. There are, I presume, some parts of the world where "consumption" has never yet ravaged, but where the inhabitants, even though free from a "tubercular history," are susceptible enough to the disorder—quite as susceptible, perhaps, as what would be termed a phthisical family. It is well known that negroes are peculiarly apt to suffer from phthisis when they come to this country, and we should probably not be beside the mark if we said of some of them, at all events, that none of their ancestors had suffered from phthisis, and the same remarks apply to monkeys.

How comes it that the hereditary element is in such cases

* Before the Fiji Islands were placed under English protection, *measles was unknown there*, but shortly after intercourse with the English the disease broke out in a malignant form.

overlooked? It is because when we speak of a disease being hereditary, we have in mind the inheritance of something peculiar to a few individuals. We do not concern ourselves about the inheritance of measles, for since practically all are susceptible (though in different degrees) to the poison, we look upon this as quite a natural thing. But the inheritance of the typical tubercular diathesis belongs to a few only; it is regarded as abnormal, and therefore much attention is paid to it. And yet in a theoretical sense we are perhaps not altogether justified in regarding the diathesis as abnormal, for the negro in whom the tubercular diathesis is pronounced, might live quite healthily in his native negro E. Nor is it necessary to assume that the peculiar condition of tissue favourable to the production of tubercle must be the same in each case, for it is conceivable that the bacillus might thrive in two or more different kinds of soil.

Although, as we have seen, all diseases are, strictly speaking, hereditary, we shall find that even in regard to those diseases which are universally acknowledged to be so, such as insanity and rheumatism, many important considerations are overlooked. One point entirely lost sight of by pathologists when inquiring into hereditary history is that a disease may gradually evolve, the predisposition to it increasing from generation to generation; the S may, for instance, gradually change from S_1 to S_8, when the disease will break out under a specific E_3; that is, $S_8+E_3=11$. There is no doubt that such a disease-tendency may evolve in the course of successive generations by the continual operation on these several generations of an E capable of generating such a predisposition. Now in such a case we might be inclined to regard the disease tendency as quite outside the sphere of hereditary influence, and, as far as I am aware, this point is always overlooked by statisticians. That they err in so doing let me demonstrate by the numerical method. Alcohol, it is well known, is a constant cause of insanity, and this peculiar effect of it is probably due to the fact that it has a special action upon nerve centres, notably the higher nerve centres of the cortex. Now let us suppose five generations to have led intemperate lives, and in each generation the predisposition to have increased by

two; then in the fifth generation the predisposition of an individual at birth will be represented by S_8. Later on in life this will increase to S_{10}, when, on a slight exciting cause ($=E_1$), he will develop the disease and the formula will stand thus: $S_{10} + E_1 = 11$. Many may object that we have no right, in such a case, to term the disease inherited, seeing that it has not actually occurred in the ancestors of the sufferer. Yet if we suppose an individual inherits S_2 from an ancestor who has actually suffered from insanity, and that he develops the disease from an exposure to E_9, the case would universally be acknowledged to be hereditary; but surely the former case, with an inherited tendency of S_8, has a greater heritage of disease.

The subject of the gradual evolution of disease through many generations has already been treated of, and let it be remembered that in all diseases thus arising the tendency is to overlook the influence of heredity.

2. In searching into the influence of heredity in the causation of any particular disease, the fact is neglected that a separate disease-tendency in each of the parents may give rise to a third and different tendency in the offspring. This hybrid result would not by many be regarded as hereditary, seeing that in such a case the parents do not suffer from exactly the same conditions, but inasmuch as each element in the resulting disease is inherited, so in a sense is the entire disease; and the same holds true of the combination in the offspring of two healthy tendencies in the parents, whereby an abnormality results (supposing such a thing to be possible, *vide* p. 79).

3. Another very common source of error is the difficulty of obtaining a proper family history. Some important incident in this history may be purposely concealed, or, what is much more likely, overlooked. In order to discover the full weight of hereditary influence in the causation of any particular disease, it is necessary to go into the family history of many generations, a course quite impossible. When we reflect that the zebra-like stripes of the horse are descended from ancestors belonging to many thousands of generations back, it is obvious that the hereditary character of these stripes could not be

ascertained if we possessed a family history dating back a few generations only, and the same remark applies here. Nevertheless, when inquiring into the hereditary history in cases of disease in man, we are only able to go back through the most recent generations; indeed, Sir James Paget, with his large experience, tells us that he has never been able to trace the family history beyond five, and that very rarely.

And here let me briefly indicate some of the apparent exceptions to the principle of heredity. According to our principle, differences other than the sexual between brothers and sisters are due to differences in the E, this E dating back to the earliest period of germ and sperm life. A very small initial difference in the E may ultimately lead to a very wide divergence. The differences of ante-partem E account for the differences among brothers and sisters at birth, but in the present state of our knowledge it would be useless for us to attempt to explain minutely the influence of ante-partem E on the child. We can, however, trace the influence of post-partem E more exactly, and I propose to touch briefly upon this influence, in order to show how it tends to obscure the hereditary principle.

Occasionally we see among children of the same parents great differences as regards mental faculty. One may grow into a remarkably clever man or woman, while another may exhibit very ordinary ability. Now, differences in mental power depend upon differences in brain organization; and inasmuch as this is inexpressibly subtle and complex, we can understand how a very slight influence may interfere with cerebral development, and thus alter, in a very marked degree, for good or for evil, the mental characteristics of the individual. And the change wrought need not be visible to the naked eye, or even with the aid of the microscope. The subtleties of thought are represented by subtleties of organization quite out of the reach of observation; so that, setting aside the ante-partem E—which, however, I doubt not, plays the more effective part—we can understand how, during the post-partem life of a child, many influences, silent and unobserved, may be modifying cerebral organization. But some of these

may be of a very palpable nature, and effect gross and obvious alteration upon the nervous system. See what a profound change rickets works upon the body: not a single part escapes, and many of the tissues are quite as seriously affected as the bones. That the nervous system is very profoundly modified is clearly shown by the great tendency to convulsions (which, as Dr. Gowers tells us, often lead to epilepsy later in life), and also to laryngismus stridulus. Dr. Barlow has never met with this disorder in a child that was not rickety.

There is no doubt that infantile convulsions and epilepsy are due to cortical change. Indeed, it has often struck me with wonder that pathologists, in seeking for the primary seat of these diseases, have so persistently ignored the large mass of cortical grey matter. Herein are situated the highest and most elaborately constructed nerve-centres; we should therefore expect them to be the most unstable in the body, the most easily unhinged and thrown out of gear. Why, therefore, seek for the primary cause of such diseases as epilepsy, hysteria, and chorea in the lower inferior reflex centres, which common sense should tell us must be more stable than the more highly evolved and supreme cortical centres, and which collectively form in weight but a small fraction of the cortical grey matter? But this by the way. Now, seeing that rickets works a profound change upon the cortical grey matter, it is obvious that the mental powers of a rickety individual must suffer from this disorder. Would Shakespeare have been the man he was if the first few years of his life had been spent in a dark and narrow London alley, even though his subsequent E had been that which he actually experienced? I have no hesitation in answering this question in the negative. Rickets must necessarily have resulted from the early E, and this disorder would have wrought a profound change in the cortical grey matter of that remarkable brain; there would have been serious disturbance with the finer developmental changes, and thus the proper progress of mind-evolution would have been interfered with. In estimating the differences in the intellectual traits of brothers and sisters, we must therefore be careful to take into account external influences. Many

are, doubtless, so subtle as to escape observation, but I doubt not that often enough the difference could be easily accounted for by observable differences in the E.

And in a similar manner we can account for marked differences between parents and offspring. Let us suppose a healthy couple, of exceptionally good physique, to come up from the country to live in the centre of London. We may safely say of their children that all of them born and reared in the lanes and alleys of the great city, will be very inferior, physically, to their parents; and we should, when comparing the parents with the children, observe an apparent contradiction to the law of heredity, for, according to it, a well-grown man and woman should have well-grown sons and daughters. Cases of this description are very common. I know of several myself, and I have heard great surprise expressed that fine, strong parents should have such puny and miserable-looking offspring. Now, let the degenerate progeny of such healthy, well-grown parents remove to healthy hygienic surroundings—such, *e.g.*, as obtain in the country—and the offspring of these will, if reared in this healthy breeding ground, tend to grow up into the physical likeness of their grand-parents—will *revert*, in fact. Here we have the reverse picture of puny and ill-developed parents rearing a well-grown and vigorous progeny, and again it is argued that the principle of heredity is fickle and mysterious. Yet I maintain that it is nothing of the kind, and that it only appears so because we fail to take into account the many influences that may disguise it. I have purposely taken extreme cases, where the difference in the E of parents and offspring has been abrupt and marked, and in which, consequently, the apparent contradiction to the law of heredity can be easily explained, if we take care to compare the E of parents and offspring; but how many are the subtler alterations of E which entirely escape our notice, and which are, nevertheless, capable of profoundly affecting mental and physical organization?

CHAPTER VI.

Disease not an Entity—All Disease comes through E—The Variability of Disease—A Perfect Classification Impossible.

THERE is a tendency to regard diseases as fixed and unchangeable types, or, if varying, as varying within narrow limits only. This belief still clings to us as a relic of the past, for it probably arose out of the old notion that diseases were separate and independent entities.

At that period of his evolution when man was first able to reason on the subject of disease, he attributed it, as he did all the various phenomena of nature, to some spiritual agency. To him a disease was an evil spirit which had taken up its abode in his body, and all his attempts at cure had for their object the driving out of the unclean thing—the exorcism of the spirit. Later on, the belief in spiritual agencies gave way to the theory of humours, which, resting though it did but very slenderly on fact, was yet more in accord with his wider knowledge of natural processes.

We shall presently see that both these views, crude and fanciful though they are, had more of truth in them than a hasty consideration would lead us to believe. One thing, however, is quite certain—viz., that it is impossible to regard disease as a separate entity, as something capable of mechanical separation from the body, of being corked up, as it were, in a bottle. One might, perhaps, be inclined so to regard it in such a case as "tapeworm," for here the mal-E consists of a worm, which, taking up its abode within the body, produces a series of symptoms, all of which disappear with the disappearance of the nocuous agent. In this case, however, the disorder consists, not of the tapeworm, but of the abnormal inter-actions which are set up by it—of improper inter-action, be it noted, of S and E. The tapeworm no more constitutes the disorder

than does prussic acid in prussic acid poisoning. It is utterly unallowable to regard the disease-producing agent as the disease itself; not only is it incorrect in point of fact, but it cannot even be permitted for practical purposes, and this for two reasons—first, because we cannot, in all diseases, accurately define the mal-E; and, secondly, because the same mal-E will sometimes induce totally different disorders in two separate individuals. Similarly, when the disease consists of a tumour, some might be inclined to regard it as a separate entity, more especially if the removal of the tumour should lead to a permanent removal of a series of symptoms caused by it; but the same objections apply here as in the previous case.

What is the fundamental truth underlying the old spiritual, (as we may conveniently term it) and the humoural pathology, and after which they were dim gropings? I take it to be this—that they tacitly assume—and in this they agree—that the essential cause of disease lies in the environment. The "unclean spirit," or "devil," and the corrupt humour, correspond to what I have termed the mal-E, or, more accurately, the abnormal internal-cell-E. In both cases the evil is supposed to be, not of the body—not part and parcel of the body fabric—but something independent of it—an independent agency, yet capable of causing disordered action in it; for although the corrupt humour was probably in all cases regarded as a product of the body itself, it was evidently thought to be independent of it (as, of course, was also the evil spirit, or demoniacal possession), and all efforts were, in either case, directed to its removal. These primitive pathologies erred in that they concentrated the attention entirely upon the E, the part played by S being largely, if not altogether, left out of account; nor would there be much need to take account of the S if every individual responded in exactly the same way to the same mal-E; but, inasmuch as different S's respond differently to the same E, we cannot possibly neglect the part played by S in causation.

Nevertheless, the E is, in the last resort, the sole cause of disease. This will be clear if we keep before us the formula "$S + E =$ disease."* If it can be shown that S is the out-

* This formula signifies vital inter-action, whether of health or disease.

come of structural modifications wrought through E, then it becomes obvious that S + E, or disease, is produced by E, and by E alone. And that such is the origin of S, there can, I think, be little doubt. Organic evolution results from the summation during countless generations of individual modifications of structure. But whence these modifications? I have again and again insisted that all are ultimately traceable to E. To assume the existence of "spontaneous" variations is to fling aside the law of causation, which tells us that nothing can happen without a cause; and what, besides E, is there that can cause a modification of S? One other cause, and one other only, can be named—viz., sexual reproduction, for this leads to the production of an organism which is exactly like neither parent, but some sort of a mean of the two. Yet I think that, even here, it may truly be said that E is the cause of the structural modification.

In order to render this evident, let us suppose that all human beings were born exactly alike, save for sexual differences, and that the E were exactly the same for all; it would logically follow that all individuals would—except for these differences—be exactly alike at corresponding ages. And if the E continued the same for each individual during successive generations, this likeness would remain permanent in the race; for the material conditions attending the coming-into-being, and the evolution of every individual of the same sex being exactly the same, each successive generation of individuals of the same sex would necessarily be exactly the same also. To deny this is to deny the law of causation. But, given modifications of E, modifications of S necessarily ensue, and it will then be impossible to get any two individuals exactly alike. It follows from this that the E is the primary cause of natural variations; once given such natural variations, however, the union of unlike individuals will still further increase the tendency to vary.

Now, the question we have to ask ourselves is this: Are we to consider the sexual union of unlike individuals as a separate and entirely independent cause of the variations thus resulting, or are we to conclude that E is here also the real cause of the variations? I contend that the latter is the correct view. To make this clear, we will suppose two individuals—male

and female—to be born into the world exactly alike, save for sexual differences. We know that in course of time each will diverge in structure, owing to the necessary differences in the E. Let us represent these structural differences, or acquired characters—say, at the age of twenty-five—by the symbols s_1, s_2 respectively. Then, if S represent those structural characters of each individual which are the pure outcome of heredity, Ss_1 and Ss_2 will represent the structure of each at the above age, when differences of E have had time to affect it. If the two individuals now come into sexual union, they will be a cross in respect of s_1 and s_2, and the coming together in the offspring of these two different tendencies will lead to a condition which may be represented by $Ss_?$—the offspring differing from the parents in respect of $s_?$. Now, seeing that the structural differences represented by s_1, s_2 have been wrought through the E, may we not justly conclude that $s_?$, which is a product of the two, has a similar origin? Each ingredient in a compound being the result of E, is it not true that the compound itself has a similar origin, even though it be quite unlike any of its ingredients? Let us suppose that in a world where O and H do not exist, each is called into being by a particular agency, at such a temperature that the two fly together to form water; should we not attribute to this agency a preponderating share in the causation of water? and similarly, if we grant that the S of two individuals coming into sexual union is ultimately due to E, we must grant that the S of their offspring is due to E, even though the offspring may manifest structural characters not present in either parent.

It is therefore, I think, clear that, directly or indirectly, all *modifications* of S come through E, and since organic evolution results from the accumulation during countless generations of individual modifications, we see that the causation of S in its entirety is ultimately traceable to E. Wherefore the material conditions represented by S and E are solely due to E, and as this formula represents not only healthy vital inter-action, but also unhealthy inter-action—*i.e.*, disease—it follows that *all disease ultimately comes through E.*

But lest any one should still maintain that such structural states as depend upon the coming together of unlike parental ten-

dencies are not wrought through E, then let me point out that the above proposition is yet to a large extent true. Although the forms of disease may undoubtedly be modified by the blending in the offspring of disease-tendencies derived from the parents,* yet it can very rarely happen that disease *originates* in this way. I have suggested† that it may occasionally happen that a condition of body rendering it liable to respond pathologically to an average healthy E, or even leading to pathological states directly, as in certain reversions—*e.g.*, persistent branchial clefts—may result from the crossing of two unlike individuals. In the former instance, however, disease is set up by the E, which must therefore be looked upon as the active cause, whether it be markedly pathogenic to the community at large or not; and as regards the second class of disorders, they are very rare, and even they, in almost all instances, result from peculiarity in the ante-partem E.

Seeing that the old notions concerning the nature of disease cannot be entertained, but that it must be regarded as an abnormal inter-action of S and E, we are prepared for the fact that diseases do not adhere rigidly to definite types, but are, on the contrary, ever variable. If no two S's and no two E's are the same, how is it possible to get any two cases where $S + E =$ the same? To assume that every disease is fixed and unalterable is to assume not only that S never varies, but that each form of specific mal-E is fixed and unalterable also, both in respect of nature and of quantity—an assumption which is obviously absurd.

Our next point is how far it is possible to classify diseases. Diseases, as we have seen, are natural variations, and, consequently, the subject must be considered from the broad point of view of biology. Let us ask how the biologist proceeds to classify? A number of living organisms, agreeing in certain fundamental particulars, by virtue of which they constitute a particular class,‡ are taken. Certain differences are observed among the various members, and by means of these the class is split up into subdivisions. Now, we may, for

* *Vide* Chapter X. Part I.

† Pp. 78, 79.

‡ I use this word in its simple logical sense.

convenience, leave out of consideration those fundamental particulars by which the different members are bound together into a common class, and concentrate our attention on those points only which are the criteria of the subdivisions, and it is allowable to regard these differences as separate and independent entities—call them species, varieties, or what we choose. In like manner the pathologist takes a class of individuals—let us say, man—suffering from various diseases, and, as every disease is probably characterized by certain structural changes, these are natural variations. Here, also, we may consider the structural peculiarities apart from those structural characters which bind men together into one common class, and thus we may speak of the different species of disease.

My object is to draw an analogy, as far as possible, between physiological variations and pathological variations, and to show that, just as physiological peculiarities of structure are to the biologist the criteria of his classification into species, varieties, and so forth, so pathological peculiarities of structure will be found to be the only rational basis for pathological classification.

How far it is possible to subdivide the several classes of disease I will not attempt to decide. I do not wish to push the analogy too far. All I want to emphasize is the fact that when we use the term species in reference to disease, we are simply referring to that structural state which constitutes the disease, abstracted, as it were, from the rest of the body, and in this sense, but in this sense only, it is allowable to regard the disease as a separate entity, just as different classes of animals or plants are separate entities.

But if we now further compare the divisions of the biologist with those of the pathologist, we shall be struck with a very marked difference between them, one so great, indeed, as to make us wonder how disease can be classified at all. Let us instance the so-called species, the lowest accurate subdivision of the biologist. In ordinary organic evolution there are constant factors at work tending to fix the species. Each is more or less perfectly adapted to its E, and if the E remained exactly the same, would undergo no alteration, seeing that perfect equilibrium (adaptation) between S and E must

sooner or later occur. Inasmuch, however, as the most stable E does change from generation to generation, the species also must of necessity undergo modifications in course of time, in order to maintain the standard of adaptation; yet, since changes in E are for the most part slow and steady, they are compelled to maintain a certain degree of fixity. They are, in fact, kept within certain limits in accordance with the great biological principle that equilibrium between S and E must be maintained. But when we turn to pathological classes, do we find that there is any principle at work tending in like manner to keep them fixed? On the contrary, pathological variations place the individual out of harmony with his surroundings, and, far from there being any factors at work tending to fix and preserve such variations, there are strong forces for ever crushing them out of existence—above all, that most potent agency, Natural Selection. Hence the wonder is that diseases admit of any classification except of a very crude order, and that any tendency whatever to definite types is manifested; for it must be allowed that there is such a tendency, although we should be greatly erring in regarding the types as fixed and unalterable. The explanation is to be sought for in the fact that physiological species are necessarily kept within certain limits, and consequently all individuals in a species are *more or less* alike. The S's, then, being more or less alike, and the various mal-E's having a certain degree of stability in them, it follows that diseases *tend* towards similarity—*i.e.*, towards definite types. It is, however, only permissible to assume *fixed* types for purposes of classification, and with the limitation that we allow for wide deviations from such types. Unless we are thoroughly alive to the extent of the possible deviations, and are, moreover, willing to acknowlege that in many cases they render classification utterly impossible, we shall be constantly falling into error.

The following two hypothetical cases will illustrate this statement. We will first suppose the S to be constant, the E varying; and, secondly, the specific mal-E to be constant, the S varying.

1. *Where the S is constant, the E varying.*—Even supposing all individuals to be exactly alike, it would still be

impossible to arrange diseases as fixed and unalterable types, owing to the fact that the several specific mal-E's are not fixed and unalterable. In some few cases it would be possible to get exactly the same mal-E, as in the case of the ordinary chemical poisons; for instance, if we suppose two individuals exactly alike structurally to take exactly the same dose of the same poison, the resulting disorder will in each case be exactly the same. But as a matter of fact, such coincidences as regards E very rarely occur, and if in so simple a case the mal-E is not stable, how much more unstable shall we find it in other cases? Take, for example, the gout-producing E. In this case the E extends over a long period of years, and, in consequence, it is utterly impossible for it to be exactly alike for any two individuals. This will be readily granted when the highly complicated nature of the external-E is borne in mind. As another instance, we may cite a specific-fever-engendering E. Inasmuch as the mal-E is in this case a poison, it might be thought that therefore its inter-action with S would be identical in all individuals coming under its influence; but such is not the case, for the poison being the product of living organisms, and these being liable to vary, the poison is liable to vary also. Hence it is that no two epidemics are exactly the same, and that they are apt to die out, disappearing from the face of the earth, while new ones come continually into being. So wide, indeed, are the deviations from the classical types of the so-called "specific fevers," and so numerous the unnamed and unrecognized forms of allied disorders, that it becomes at once evident how very imperfect their classification must be, and that a very elastic meaning to any terms we employ to denote these types must be allowed. This subject has been so ably discussed by Dr. W. J. Collins * and Mr. Millican,† that it is unnecessary to pursue it further.

The same line of argument applies to all forms of mal-E. They are essentially variable, and such being the case, the diseases which they cause must be variable also, even though the S be the same; and inasmuch as the S of all individuals

* "Specificity in Evolution," by W. J. Collins, M.D., &c. This is a valuable paper, and deserves careful study.

† "The Evolution of Morbid Germs," by Kenneth W. Millican, M.B.

differs considerably, how much greater reason is there that diseases should be variable?

2. *Where each specific form of mal-E is constant, the S varying.*—As an example of a theoretically fixed mal-E, let us take a chemical poison—say, prussic acid. Now, since the S is in no two cases the same, it follows that the resulting disorder—prussic acid poisoning—can never be exactly the same either. It may be thought that this is mere hair-splitting; but I maintain that it is simply logical, and consistent with the admissions we have been compelled to make. Suppose that the resulting disturbance were entirely different in the two cases, should we still be justified in regarding the disease as at all the same, even though due to the same amount of the same poison? In prussic acid poisoning the effects would, I admit, probably be *very much* the same in all cases; but we know that different individuals differ very considerably in their mode of response to different kinds of poisons—and this shows us that the nature of the E is not an absolute criterion of the nature of the disorder, and hence, as we have seen, one reason why we cannot classify diseases according to their external causes. In the case of chemical poisons, the specific mal-E no doubt forms a valuable means of classification—for practical purposes at all events—and when called to a patient suffering from prussic acid poisoning we should not enter into a disquisition on the nature of the morbid changes, but, knowing prussic acid to be the disturbing agent, should proceed with all promptitude to take such steps as are known to be useful in counteracting its effects.

Seeing, then, that even if, on the one hand, the S were always constant, or if, on the other, E were always constant, diseases would still vary very considerably in type, and seeing, moreover, that, as a matter of fact, both S and mal-E are variable, the truth that disease types are variable becomes at once obvious.

Variability in S, perhaps even more than variability in E, is a cause of variability in disease. No doubt there is a certain likeness in all individuals of the same species in respect of their response to specific mal-E's, and since these latter also

maintain a certain degree of constancy, it is possible to recognize diseases as belonging to a particular species, and to apply to them the term "specificity," with certain qualifications. No one will doubt that rheumatism, tubercle, diphtheria, carcinoma, and typhoid fever are distinct and definite diseases; but even these well-defined diseases deviate very widely from their classical types, so much so, indeed, that they may be utterly un*re*cognizable, in the truest sense of the term. But if this is true of such well-recognized disorders, how much more is it true of others? Instance cutaneous and nervous diseases. Diseases of the skin are so variable that they have completely baffled the most diligent attempts at classification. Yet if a rare case come before the specialist, he is not content unless he can refer it to one class in his long category; he is unwilling to regard it as a unique disorder, as one the like of which has, perhaps, never occurred before, and may never occur again. He might, I will venture to say, learn a lesson from the horticulturist. Diseases are, as we have seen, natural variations. Now, when a gardener meets with a natural variation in one of his plants, he knows very well that such variation may never have occurred before, and may not be repeated, and in consequence, if the variation be one favourable for his purposes, he is most careful to "fix" it, as it were, to preserve the seeds, and to exert all his efforts to accumulate and intensify the peculiarity during successive generations of the plant. In like manner unique pathological variations of the skin may occur. We have seen that variations are more abundant among domesticated animals and plants, and among civilized peoples than among organisms in their wild "natural" state, and that this is largely due to instability of E. Just as plants vary abundantly in an unstable E, and from the crossing and recrossing of varieties, so may the human skin vary abundantly in the unstable civilized E, and from the crossing and recrossing of unlike individuals; and, inasmuch as mal-E's are numerous in civilized communities, there is no wonder that pathological variations should be numerous, that they should baffle the most careful attempts at classification, and that fresh ones, quite unlike any which have before occurred, or which may ever occur again, should from time to time appear.

Then, as regards nervous diseases. Let us first instance the

affections of the spinal cord. In most text-books these are classified with great care and precision, and the student sets himself to learn them diligently. But what does he find when he comes to observe for himself? That he very rarely meets with the disease exactly as described in the book. He soon learns that, with few exceptions, he must consider each case on its own merits, and that that physician makes the best diagnosis who can specify the particular parts of the cord that are diseased and the nature of the pathological process, and who is content to rest there, without necessarily pigeon-holing the disease into any special department, and racking his brain to make the case accord with some particular classical type.

These remarks apply with double force to mental disorders. It is truly pitiable to examine into the ponderous literature of those most wonderful of all diseases—diseases of the mind—and to contemplate this craving for classification. Of all diseases, mental diseases are the most subtle, and of all, perhaps, the most variable; but the author, in his desire to classify, is painfully anxious to set rigid limits even to them; and so it is with all. Every man, when he leaves hospital, and has to deal with diseases on his own responsibility, must be struck with the vast difference between disease as he has learnt it from the books and as he actually finds it. For some time he endeavours to name every case, but, if he is a thoughtful man, he soon discovers the futility of this; he learns to consider every disease on its own merits, and thus, while he makes full use of classifications and types, he is ever prepared to meet with cases which stand alone, which never have "been" before, and perhaps never will "be" again.

These considerations it was that led me, when speaking of terminology, to say that "it matters little by what word, or combination of words, we choose to designate any particular disorder, so long as we have a clear idea of the morbid inter-actions (or what is known of them) which the name chosen is intended to connote; and inasmuch as the morbid inter-actions are in no two cases even of the so-called 'same' disease, exactly alike, we must allow a considerable latitude to the meaning of any term, modifying it in different cases according to our exact knowledge of the morbid process."

CHAPTER VII.

The Parasitic Origin of Malignant Growths.*

Some little time ago I came to the conclusion, on *à priori* grounds, that malignant growths must be caused by parasites, and I wrote down my arguments with the intention of publishing them on a suitable occasion, not knowing that the theory had already been advanced. Having read the interesting experiments of Mr. Ballance and Mr. Shattock, I am led to publish my views.

The phenomena of life fall under two main heads, the first relating to the organism, the second to its environment. Let us symbolize the former by the letter S, the latter by E. Now, confining for the moment our attention to a unicellular organism, we know that if the cell and its environment be properly constituted, a certain interaction takes place, and this is healthy life. S + E represents a set of material conditions which inevitably issue in healthy inter-action, and these material conditions are the cause of life. But if either S or E be improperly constituted, either no vital inter-action takes place at all, which is death, or an improper vital inter-action occurs, and this is disease. Wherefore disease may be defined as an abnormal mode of life. These remarks apply likewise to multi-cellular organisms. Every cell in such organisms is surrounded by a space which constitutes its E, and the life of a multicellular organism at any one moment consists

* This chapter is inserted here to show the principles set forth in this work in actual application. It was originally intended for publication in one of the medical journals, but as it only appeared there in abstract, I deem it advisable to insert it here in full, and at the risk of some repetition, as the method of argument followed is based upon the principles I have been endeavouring to enunciate. I should add that when it was first written the parasitic theory was unknown to me.

of the sum of the inter-actions of the several cells composing the organism and their individual environments. Wherefore, in speaking of E, we must remember that we have to deal, not only with an external-body-E, in the shape of food, air, and so forth, but with an internal-cell-E also. This latter is, in great measure, dependent upon the external-body-E, but it is also very largely under the control of the body itself; so closely, indeed, are the several tissues of the body bound up into one physiological whole that it is quite impossible to get a serious change in one part which shall not lead to a more or less universal modification of cell environment. And here let me remind the reader that a properly constituted E not only includes certain positive conditions, such as the presence of oxygen and proper food, but also certain negative conditions, such as the absence of waste products.

Now, disease being an improper inter-action of S and E, it follows that the cause of disease must depend upon—(1) peculiarity of S; (2) peculiarity of E; or (3) peculiarity of both. Wherefore, in seeking for the causation of disease we must first inquire into the causation of S and E. As regards S, at least $\frac{99}{100}$ of its causation must be referred to heredity, and there remains but one other factor capable of affecting it—viz., the environment. The influence of E may be summed up in the following proposition: whatever structural peculiarity an individual exhibits which is not the pure outcome of heredity is wrought through E. I have elsewhere shown my reasons for what may seem a somewhat dogmatic assertion, and we need not therefore discuss the matter again here. Heredity and E are, then, the two great moulding powers. Let S represent such of the structure of an individual as is the pure outcome of heredity, and s that part of him which has been shaped by E, then Ss expresses the causation of structure at any particular time. If, now, the individual come into contact with an agent producing disease in him, the formula Ss + E represents the causation of that disease. It represents, in fact, a set of material conditions which necessarily issue in unhealthy inter-action. Let us, for instance, suppose it proven that cancer is due to parasitic action, then, if E stand for the environment of the individual (including the parasite),

Ss + E will represent the causation of cancer in any given case. Observe the importance of s. It might so happen in a particular case that Ss + this same E would not cause the disease, even though the S were the same as in the first case. The s, which represents the moulding of the body through a series of years, might have been a totally different quantity from that in the first case, and one preventing the specific E from working its dire effect upon the body.

Let it ever be borne in mind that we can never exclude S from the causation of disease. How is it possible to do so, seeing that disease is an abnormal inter-action of S and E? Occasionally, for practical purposes, we may. When a man breaks his leg from a fall, we do not say it is his leg that is the cause; but if two healthy individuals be equally exposed to the scarlatina poison, and only one contracts the disease, it is evident that it is impracticable to exclude the S from a share in causation.

One word on what may be termed the *potentiality of S.* The tissues are endowed with a vast number of potentialities—that is, slumbering possibilities—dormant states needing but a fitting E to awaken them into actual being. This subject has not, in my belief, received its proper attention from pathologists. Whatever be the evil factor in the causation of malignant growths, it is to be noted that the affected tissues must possess the potential power of taking on the particular morbid action, and in the cancers the structure of the growth is by no means simple. The power of thus growing must have been previously locked up in the affected tissue, so that even if we find a parasite to be the exciting cause of cancer, we must remember that the power of growing in this peculiar way belongs to the body.

With these remarks on the Causation of Disease in general, let us now proceed to discuss the causation of cancer in particular.

The question—Does the tumour originate in a multiplication of the few cells initially constituting it, or in a transformation of the affected tissues?—must first engage our attention. It may obviously originate in either, or in both, of these ways. All

are agreed that the primary carcinomata increase, for the most part, by an actual transformation into malignant tissue of the tissue primarily affected, and in no case is this more beautifully shown than in carcinoma of the kidney. But some pathologists doubt whether the sarcomata ever originate in this way, the tumour growing, in their view, simply and solely by a multiplication of the few cells initially constituting it.

It is, with our present knowledge, almost impossible to decide this question. Inasmuch, however, as all are agreed that primary carcinoma is a transformation—at all events, in part—there is no need to assume in carcinoma a group of previously existing embryonic cells, as some have done, because we have very distinct proof that the tumour is, to a large extent, developed from mature tissue. Although many of the cells constituting a primary carcinoma are derived from the normal cells of the parts, yet there is not the slightest doubt that very many of them arise from a multiplication of the cells already constituting the tumour. Indeed, this seems to me to be more certain of the carcinomata than of the sarcomata, for connective-tissue elements are everywhere present; therefore, in no matter what direction sarcoma spreads, or in what parts it is secondarily produced, the proper elements are always at hand to share in the formation of the growth; but it often happens that carcinoma spreads to tissues, either directly or by secondary reproduction, in which there are no epithelia—the growth in such cases evidently occurring by a multiplication of cells already belonging to the tumour. Squamous epithelioma, to wit, may directly extend to bone, or it may be secondarily reproduced in a tissue containing no squamous epithelia. The reason why the primary tumour contains squamous epithelial cells is certainly because the tissue in which the growth started is largely made up of such cells. The tissues secondarily affected contain none such. Now, if the cancer had first attacked the tissues thus secondarily affected, the tumour would certainly not have contained squamous cells, for a primary squamous epithelioma never starts in tissues devoid of these cells. From this, two conclusions seem to follow—(1) The primary tumour derives its squamous epithelial cells from previously existing similar cells; (2) the squamous epithelium of the secondary

growth is derived from a multiplication of cells transported from the primary tumour. Now, if this is true of one form of carcinoma, why may it not also be true of the others, and, indeed, of the secondary sarcomata likewise? When the carcinoma is reproduced in a tissue containing no epithelia, these cells are probably derived solely from the multiplication of transported cells; but when the secondary carcinoma occurs in a suitable epithelial tissue, the growth may be both by a multiplication of transported cells and of the normal epithelia of the part. Such a twofold cell-origin is possible with all the sarcomata, for connective-tissue elements everywhere abound.

How comes it that a tissue, hitherto normal, suddenly takes on malignant growth? * The cause must, as we have seen, depend either upon—(1) an innate tendency of the tissue primarily affected to undergo the malignant change independently of a peculiar E; (2) upon a distinctly peculiar E; or (3, and finally), upon abnormal tissue tendency combined with peculiar cell-E.

Is malignant disease due to an innate tendency on the part of the tissue primarily affected to become malignant, independently of a peculiar cell-E? Is the process analogous, in fact, to the differentiation of tissue which occurs in the process of development, a differentiation which certainly takes place independently of distinctly peculiar E? I say "distinctly peculiar E," for doubtless the nature of individual cell-E plays an important part in development. This fact is sufficiently attested by a study of the laws of correlation, for if one particular part be peculiarly affected in development, others are sympathetically influenced, doubtless through the influence of one tissue on the cell environment of others. Sir James Paget, in his clinical lectures, evidently assumes such an innate origin, an origin essentially through S and not through E. For he argues thus:—Some individuals exhibit a tendency to super-

* I say suddenly, for although Hutchinson has spoken of a pre-cancerous stage—an inflammatory state preceding the actual cancerous change—it must be conceded that there is by no means proof that this always occurs; malignant change may, beyond all doubt, be suddenly set up in a healthy tissue, and this practically always happens in the case of the secondary growths.

numerary fingers; there is no hard distinction between these and hereditary fatty, glandular, cartilaginous, or osseous growths; these again cannot be separated from definite tumours of similar structure; finally, there is no abrupt step from innocent tumours to recurrent fibroids from which true cancer may be evolved. Now, I do not allude to this particular view in order to subvert it; for Paget is most careful to impress upon his readers that the above may not be the exact mode of evolution, and that he merely "hazards a guess"; I mention it only because it shows that when he wrote the lecture his mind was dwelling upon the S—that he was thinking of cancer as evolving through S, and this indeed is one possible origin of malignant disease.

The growth of a malignant tumour is most remarkable. A tissue which, it may be, for many years has been living healthily, suddenly and sharply diverges from its wonted mode of growth. The change is not a mere hypertrophy or atrophy, nor is it simple degeneration, any one of which may be brought about by the body through its own power of modifying cell-E—of increasing or decreasing blood-supply or of modifying nerve influence. The process is quite peculiar, for, while the nutritive activity of the part is actually increased, and sometimes enormously so, the change is a retrogressive one, the tumour-tissue, taken as a whole, being not only quite different from that of the surrounding parts, but also of inferior value from an evolutionary point of view. Now, bearing in mind that every cell in the body is a separate organism, surrounded by its own special E, this peculiar behaviour on the part of a tissue which for years has been calmly and peacefully carrying on its proper functions, is strongly suggestive of a sudden and peculiar modification of its cell-E. In a meadow we sometimes observe dark patches of grass growing more luxuriantly than the rest, and, on seeking for the cause, we find that it is due to altered E, in the shape of a different soil; similarly, if in the body we observe one patch of tissue taking on luxuriant and abnormal growth, a modification of E is strongly suggested.

But, even though the abnormal growth be due to a peculiar cell-E, this might conceivably be independent of any peculiar external E; it might, namely, be wrought by the body itself

through the power of one tissue to alter the cell-E of another, in which case the chief share of causation would belong to S—that is, to the body, and not to any agent independently of the body: the growth would, in short, be due to an innate tendency of the body to undergo the change independently of external nocuous agent. But is the body capable of affording the necessary E? By modifications of blood-supply and nerve influence, the nutrition of a part may be influenced, and thus we may get hypertrophy, atrophy, or degenerative changes, but I know of no nutritive change thus wrought which is at all akin to the malignant change. In derangement of the nervous system, for instance, rashes, sloughings, and many other changes may occur through modification of cell-E; but these differ from the malignant changes in several important particulars. In the first place, a malignant tumour starts from a microscopic centre, and spreads thence, while ordinary "trophic" and degenerative changes start more or less evenly throughout the whole of the affected area; then again, in trophic changes, there is, for the most part, diminution in the bulk of the affected part; further, in the case of secondary growths we can eliminate any such trophic influence.

A study of the mode of growth of the malignant tumours is, I say, strongly suggestive of a sudden change in the cell-E of the affected parts. There is nothing to be said in favour of the growths being due to an innate structural tendency, independently of a localized specific mal-environment, and there are several arguments against this view. If we assume the chief element of causation to reside in S, we must narrow down the primarily faulty S to a very minute area—to an area, indeed, of microscopic proportions. Then, again, all acknowledge a sudden change of E in the case of the secondary tumours: these never occur from an innate tendency of the affected tissue to undergo the malignant change, independently of altered E. Finally, the change is retrogressive; there is not evolution, but dissolution, and one patch of tissue never takes on a dissolutionary change independently of altered cell-E. I shall have shortly to revert to this subject of retrogression.

The theory that malignant growths are developed from

unused embryonic tissue, although it does not entirely exclude a specific E from a share in causation, obviously refers a large part of causation to peculiarity of S in the shape of unused embryonic tissue. This theory is at once improbable and useless. We do not find, except perhaps in a few cases of sarcomata, that malignant growths have a predilection for parts where we should expect such embryonic remains to abound. There is no part of the body which may not be affected with some one or other form of malignant disease. Local irritation, rather than embryonic remains, determines the exact site. This is very noticeable in epithelioma. Why should embryonic remains be more particularly present in such part of the tongue as lies under a sharp tooth, or in those parts of the alimentary canal most subject to irritation? Indeed, if the embryonic view be correct, embryonic remains must be scattered throughout the whole body, and this surely robs the theory of all its force. And it is not only an improbable, it is a useless, theory—it explains nothing. If there were distinct evidence that the entire tumour in all cases originated from the first few cells constituting it, the fact would be in favour of the embryonic theory; but, inasmuch as it can be proved that in many cases of malignant change the tumour is formed by a transformation of previously existing mature tissue, the theory is useless, for we can do without it. It may perhaps help us to explain innocent growths, but it in no way helps us to explain the leading characteristic of malignant growths, viz., their infectiousness.

I said that malignant change was a retrogressive one. In all cases of new formation occurring as the pure outcome of heredity, the change is evolutionary, from the homogeneous to the heterogeneous, from the less complex to the more complex. Malignant change, on the other hand, is essentially dissolutionary. We are thus led to discuss the nature of sarcomatous and carcinomatous tissue. All agree that the tissue of sarcoma is of a very elementary kind. The same kind of tissue is abundantly met with in the embryo and in the simpler forms of life. The sarcomatous change is, therefore, a reversion; it is the manifestation of one of the many

tissue-potentialities. The carcinomata, however, have no such simple structure; but I have no hesitation in affirming that in their case also the change is a backward one. Some pathologists have spoken of endothiomata and other hypothetical kinds of malignant growth, and I doubt not that eventually our classification of the malignant tumours will be less simple than it is now. For the present I wish to leave all such doubtful forms out of account, and to speak only of the well-recognized and typical forms of cancer. There can, I think, be little question that such forms belong to the glandular type. This is very plainly shown in the case of the epitheliomata. In the squamous variety the epithelial cells dip down just as in the development of all open glands. All the intestinal open glands are thus developed, not even excepting the liver; but, observe, the down-growing cylinders never become hollowed out. The glandular tissue is, therefore, of a very crude, immature form—of a form like that which probably obtained in some very remote form of ancestral life, for, at its first evolution, the in-growing gland was almost certainly solid. In the cylindrical-celled variety a more perfect type of tissue is approached, for the cylinders contain a distinct lumen; nevertheless, the process is disorderly, and the gland-tissue, taken as a whole, is decidedly imperfect. In the acinous forms of cancer the glandular type is maintained, but it is distinctly of an erratic kind, and the fact that the acini are generally crammed with epithelial cells is probably due to the rapid multiplication of these latter. But it is a noteworthy fact that in many instances there is a distinct tendency to a regular arrangement of the cells as a single layer on the walls of the acini, when the true glandular nature of the tissue becomes manifest; wherefore we may say that the carcinomata consist of an immature and disorderly form of gland-tissue. The change is, consequently, a backward one; it is not an evolution, but a dissolution, the affected tissues manifesting some one or other of the countless potentialities locked up within them.

I mentioned the dissolutionary nature of the malignant change as an argument in favour of its being due to some modification in E, for, so far as I know, rapid dissolution cannot take place except by alteration of cell-E. Many pages

would be required to make good this assertion. I must content myself with asking the reader to believe that I do not make it without sufficient reason. Even the slow retrogressive changes of old age can in most cases be traced to imperfections in the cell-E, from failure in the organs which make and conduct the blood. It is at this time that fatty changes abound, and that fibrous tissue begins to replace the epithelial. The cell-E is no longer capable of enabling the tissues to maintain their high structural standard, wherefore reversion to a lower order of tissue occurs; under the imperfect cell-E a struggle for existence ensues, and it is no wonder that the hardy connective tissues increase at the expense of the delicate epithelia.

Here let me point out an important distinction between such degenerations as the above, and the malignant degeneration. In all cases of senile degeneration the imperfection of cell-E lies in the absence of some positive essential to life, but in the carcinomata there is no such absence, since growth is excessive; therefore, although the malignant growths are degenerative in the strictest sense of the word, and must in consequence be due to some modification of E, this modification is quite different from that which causes the degenerations whereof I have just spoken. In malignant degeneration the abnormal E must be a *plus* quantity; it must contain some irritant. The essentials of organic life, such as food, oxygen, and so forth, must be at hand in abundance, and over and above these essentials there must be a something which disturbs the growth of the tissue as a whole (not necessarily of individual cells, for in carcinoma the epithelia may grow most luxuriantly). We saw that a perfect E requires not only the presence of the essential, but the absence of the hurtful; wherefore the abnormality of the E of malignant tumours lies in this second particular.

Our present position may be thus summed up:

(1) Malignant disease is due to an abnormal cell-E of the affected tissue.

(2) The abnormality consists, not in the absence of the essentials to life, but in the presence of some noxious agent.

(3) The mal-environment is not wrought through the body, but consists of something not of the body.

We have now to inquire into the nature of this mal-E. Malignant disease is often precipitated by mere mechanical irritation, such as that caused by a blow, soot, a sharp tooth, and the like. The effect of mechanical irritation in causing malignant disease, notably cancer, is well known. Thus we explain the great frequency of this disease in the mammæ, the cervix uteri, the lips and tongue, and such other parts of the alimentary canal as are most exposed to injury. But is this irritation alone sufficient to account for the abnormal growth? It seems on the face of it very improbable that it should lead to the production of a tissue totally unlike that produced by mechanical irritation in general. It is, of course, open to us to suppose that the tissues have an innate tendency towards malignant change, and that a mechanical irritation is capable of starting it. *Of starting it*, I say, but not *of continuing it.* We have already seen that a specific mal-E must play a large share in the causation, but mere mechanical irritation does not fulfil the necessary conditions. In the first place, malignant tumours occur over and over again independently of such irritation; indeed, this is always the case with the secondary malignant tumours, when, therefore, some other mal-E must be at work. In the second place, the malignant degeneration is continuous; once started it goes on with awful determination, and a continuous effect implies a continuous cause. And since a peculiar cell-E plays an essential part in the causation, *we require a mal-E which abides during the whole period of growth.* Consider, for instance, the primary carcinoma, which grows chiefly from the mature cells of the tissue affected; every newly affected cell requires the specific mal-E. Now, inasmuch as the tumour continues growing after the removal of the mechanical irritation, it is obvious that this latter cannot constitute the specific mal-E.

The form of mal-E which meets all the peculiarities of the case is one consisting of a living organism, for it is an abiding mal-E; and if satisfactory proof has been given that the essential portion of malignant pathogenesis belongs to some continuous mal-E, then, I think, we may take it as all but experimentally proved that this mal-E consists in some specific bacterium, which thus comes to be a necessary element in

causation. Such an organism accounts for the characteristic feature of the malignant growths—viz., their infectiousness.

My view is this: *Under the bacterial irritation, the tissues are unable to keep at their normal level, and revert to a lower order of tissue, thus exhibiting some one of their many potentialities.* The type of morbid tissue thus produced depends (1) upon the nature of the tissue primarily affected and (2) upon the nature of the parasite.

We have seen that the secondary growths are not always due to the transformation of the affected tissues, and in such cases we cannot say that the affected tissues revert. The secondary tumour in these cases results, I believe, from the *transference of tissue-cells + the bacteria from the seat of the primary affection.* Under the stimulus of the parasite, these transported cells take on, by virtue of their potentialities, the same morbid action as at the primary seat of infection. It is impossible, however, to deny the cells of the tissue secondarily affected some share in the process.

Here, however, a difficulty presents itself. The question may be pertinently asked: Why should the transported cell show such a tendency to grow in the new site? One can understand, it might be argued, how a specific parasite may cause a reversion in the primary site, but it is not so easy to understand how it can cause the transplanted cell to grow in the secondary site, since this does not occur in the case of innocent tumours. As a matter of fact, however, it has been known to happen. Simple adenoma of the liver has been known to give rise to secondary adenoma of the kidney. This is a very important fact, for it relieves the parasitic theory of what might otherwise be a great difficulty. The greater frequency of secondary growths may, I believe, be explained as follows:—(1) Certain anatomical peculiarities of the primary tumour permit the transference of the tumour cells. In the innocent tumours the cells are far more fixed than in the malignant, and in reference to this question of fixity it is important to note that the rate of secondary reproduction is generally in direct ratio to the rate at which the primary growth develops; that is to say, to the looseness of the cells. A further anatomical peculiarity favouring the transference of

cells from a malignant growth, is the peculiar arrangement of the lymphatics in the carcinomata, and the peculiar embryonic condition of the capillaries in the sarcomata. (2) Not only are the tumour cells more frequently carried away from the malignant growths, but the conditions obtaining in the tissues in which they lodge are more favourable for their development than for the development of cells carried away from innocent tumours, because in the former case the transported parasites probably set up an inflammatory hyperæmia in the area of secondary infection, and thus the transported tumour cells have a better chance of survival.

Although, therefore, the presence of the parasite in the site of the secondary tumour probably does actually increase the chance of survival of the transported cell, the parasitic theory is not essential to an explanation of this survival; but it is needed to explain the fact that the cells thus surviving in the abnormal site take on the same form of retrogressive change as in the primary site. The material conditions being the same in each case, viz.: (1) certain tissue cells; (2) specific mal-E, the result is in each case the same.

It would, however, need far more space than I can here give to develop this bacterial theory in all its details, and I must confine myself to its more leading features. There are probably several varieties of "malignant" bacteria. In the first place, the carcinoma parasite must be different from that causing sarcoma; it differs both as regards its *habitat* and its *virulency*. As regards the former, it is apparently in the epithelia alone that it can thrive, but it further differs from the sarcoma parasite in that it is much less virulent. Carcinomatous tissue is infinitely more complex than sarcomatous, for not only does it contain mature connective-tissue and epithelial cells, but the tissue elements are arranged in a very definite way. Sarcomatous tissue, on the other hand, contains, besides the embryonic blood-vessels, connective-tissue elements only, and these, moreover, in a very immature form, and with little, if any, tendency to definite arrangement. In short, the dissolution is far more complete in sarcoma than in carcinoma, and consequently the irritation must be greater—the parasite must be more virulent. Connective tissue

is capable of surviving under conditions in which the epithelial cannot. How well this is shown in the example already quoted, of the fibrous degeneration of old age, when, owing to the imperfect cell-E consequent upon failing blood-making and blood-carrying organs, the fibrous tissue develops at the expense of the epithelial.

The presence of the carcinoma parasite is not incompatible with the growth and multiplication of epithelial cells; on the contrary, under the general disturbance of bacterial irritation, their activities are actually hurried on, and a more or less crude form of gland is produced, and the dissolutionary nature of the process shows itself chiefly in the imperfect arrangement of the cells. Whether the epitheliomata are caused by a different parasite from the acinous varieties I will not venture to say, but all the latter are probably produced by the same organism.

In the sarcomata, on the other hand, the bacterial irritation is so virulent that under it only the most elementary forms of connective tissue can survive. Inasmuch as this latter order of tissue is everywhere present, there is no very pressing reason to suppose a special tissue habitat for this organism. How far the varieties of sarcomata are due to differences in the organisms causing them it would be difficult to decide, for who can say how far the type of malignant tissue is determined by the structural proclivities of the tissues affected, and how far by specific parasitic action? Certain it is, however, that the structural differences of the sarcomata are very largely due to corresponding differences in the bacteria causing them; thus the small, round-celled variety is probably due to an excessively virulent parasite—one so virulent, indeed, that it permits the survival of the most rudimentary order of tissue only. That, on the other hand, the nature of the tissue affected plays a part in determining the type of morbid tissue, is shown by the fact that myeloid sarcoma most frequently originates from the medulla of bone where giant cells abound, and the melanotic variety solely from the pigmented tissues. This fact is equally well shown in the case of the carcinomata: the primary cylindrical-celled epitheliomata originate in tissues containing cylindrical epithelial cells arranged in tubular glands, and the primary squamous variety solely from tissues containing squamous epithelia.

The above remarks are borne out by what we know of nutgalls, the structure of which depends, as is well known, upon the structure of the plant-tissue affected, and upon the nature of the parasite. Darwin speaks of the important share taken by the latter in determining the structure of the gall. Many species, he observes, may grow on the same tree, and their difference is due to the subtle differences in the chemical composition of the poison emitted by the several species of gnats. A subtle shade of difference in chemical poison is, then, capable of producing a palpable difference of structure. Surely, a most noteworthy fact.

I have said that the transported malignant cells share in the production of secondary growths. Consider the carcinomata; their complex structure is faithfully reproduced in the secondary growths, even though the tissue secondarily affected contains no epithelia. Assuming that the transported cells do not multiply, the secondary growths may be accounted for in two ways. (1) We may suppose that the specific bacterium is capable of producing the same tissue-transformation in whatsoever tissue it may happen to lodge, for, be it observed, the essential part of my hypothesis consists in this: that under the bacterial irritation the tissues primarily affected undergo dissolution, manifesting some or other of their many potentialities—undergoing, in fact, what may be called vitiated reversion. But it would be ridiculous to assume such an origin for all cases of secondary growths—to suppose for instance, that a secondary epithelioma, whether squamous or cylindrical, of—let us say—a lymphatic gland, could originate by reversion; there is no ground whatever for supposing that adenoid tissue, belonging as it does to the connective group, contains within itself the potentiality of such a complex gland-like structure. (2) The other hypothesis is sufficiently designated by the word "spermatic," and, judging from the attention it has received in works on pathology, it has been widely accepted. Yet it is utterly unscientific. It assumes that the cells of one tissue can, by mere contact with the cells of another tissue, compel the latter to grow like themselves. What warrant have we for such an assumption? Certainly not one biological fact; in-

deed, the theory involves an entire misconception of true spermatic influence. The sperm does not, by mere contact, compel the germ to grow like itself, or like the being from which it is derived. What happens is this: The two unite, and the blended mass grows into a being which is a mean of the two from which each sprang. If, therefore, the spermatic theory were correct, the secondary growth should be a structural mean between the tissue of the primary growth, and the tissue in which the secondary growth occurs, which it is not. We are driven, therefore, to the conclusion that the transported cells take an active share in the production of those secondary carcinomatous growths which occur in tissues unlike that primarily attacked. The tissue-cells are carried away from the primary growth, together with the specific bacterium, and under the irritation of the parasite they continue in their new site to behave exactly as before; for they will of course go on living if they find a suitable E,—if proper food and oxygen be brought them, and if the cell-excreta be removed. And this suitable E is provided by new blood-vessels and lymphatics, which are developed under the bacterial stimulus. The conditions of epithelial life thus obtaining, there is active epithelial growth, and, given such growth, what wonder that the epithelial cells should exhibit the same arrangement and general tendencies as in their native site? Let us reflect that a single cell taken indifferently from an organism—from a begonium leaf, for instance—is often capable of reproducing the entire organism; and that, as Herbert Spencer has argued, this power is probably possessed in greater or less degree by every cell of every organism, be it ever so complex. Shall we then grant such tremendous potentialities to a single cell, and deny to our transported epithelial cells the narrow powers of growing and arranging themselves in a manner like that obtaining in their native tissues?

I have said that the carcinoma parasite is favourable to cell life: the subsequent degenerative changes are in large part accidental, so to speak, for the most serious result either from a contraction of fibrous tissue or from the breaking down of too rapidly forming blood-vessels.

What has been said concerning the part played by trans-

ported cells in the production of the secondary carcinomata applies also to the secondary sarcomata, but with less force, seeing that connective-tissue elements abound everywhere, and that sarcomatous tissue has no very definite arrangement. We might, with some show of probability, suppose the same sarcoma parasite to bring about the same kind of dissolution, no matter in what tissue it lodged, one kind of bacterium producing round-celled sarcoma, another the giant-celled variety, and so on, in whatever tissue it happened to strand. There is, nevertheless, strong evidence that even in the sarcomata the transported cells share in the production of the secondary growths. I was careful to point out that the giant-celled structure of central bone sarcoma depended rather upon the nature of the tissue primarily affected than upon any special power of the bacterium to cause this particular mode of growth, that in another part this same bacterium would have produced a different kind of sarcoma. Now, inasmuch as secondary myeloid sarcoma of bone exactly resembles the primary growth in structure, the probabilities are very strongly in favour of the former having arisen in large part, not from a transformation of the tissues secondarily affected, but from a multiplication of the transported medullary cells, these behaving under the bacterial irritation just as in the primary growth. The same line of argument applies to the secondary osteoid sarcomata; it is not likely that the bony tissue in these growths is due to transformation. I have little doubt, however, that this latter process does take an active share in the secondary sarcomata, more especially as regards round and spindle cells.

The fact that malignant growths occur by preference in tissues whose vitality is lowered from any cause is strongly in favour of the parasitic theory. There can be little doubt that a continual struggle for existence takes place between the tissue-cells of a multicellular organism on the one hand, and independent unicellular organisms on the other. Under ordinary conditions of health the former obtain the mastery, but whatever lessens tissue vitality places the tissue-cells at a disadvantage in the struggle, and hence it is that their diminished vitality favours parasitic development.

It may be asked how the "malignant" bacteria irritate the tissues. I can conceive of only two ways—(1) by mere mechanical irritation; (2) through some poison which they emit. The latter is, doubtless, the source of all the trouble, just as it is in the case of the gall-gnat. In the latter case, however, the growth never exceeds certain well-defined limits, because, of course, the supply of poison is limited.

The granulomata are admitted to be caused by parasites, and why not the malignant growths also? All these formations are bound together by the common bond of infectiousness, and this suggests, nay, almost demands, some common cause. Further, there is a marked similarity in the structure of granulomata and sarcomata. The simplest way of explaining infectiousness is to assume the existence of a parasite, for this gives us an abiding mal-E, and hence a continuance of the morbid process. The bacteria causing the several varieties of granuloma and those causing the sarcomatous growths, are equal in virulence, as is proved by the extent of dissolution being equal in both. It is important to distinguish between *virulency* and *capacity to live on in the tissues.* This latter power is possessed in a far greater degree by the "malignant" than by the granuloma parasites, for, in the first place, the granulomata have far less tendency to spread at the periphery, and, secondly, they are more apt to abort, as not unfrequently happens with tubercle, for instance. The granulomata are generally thought to be inflammatory, and some have even maintained that all inflammations are due to bacteria. This view is probably erroneous; but, be that as it may, it is quite certain that in those cases where inflammation is permanently arrested the mal-E must cease with the cessation of the inflammation; wherefore, if this mal-E consists of a bacterium, this must lose its activity, as not unfrequently happens with the granulomata. The malignant growths, on the other hand, very seldom abort.

How are we to account for the fact, for fact it unquestionably is, that malignant disease so often runs in families? Doubtless,

because such families afford the fitting soil. Let him who is inclined to scoff at the "soil" theory explain the preferences of other parasites for particular individuals and for particular bodily states. Let him tell us how it is that ordinary skin parasites show undoubted partialities—that, of two individuals equally exposed to the same bacterial influence, one is stricken with fever while the other escapes unhurt; that the heads of patients who have been tended with the utmost care will sometimes of a sudden swarm with vermin; and that, as death creeps upon an individual, myriads of bacteria, hitherto quite powerless to hurt him, swarm the tissues, beginning their work of destruction ere life is yet extinct. These and kindred facts can only be explained by supposing that certain states of the body are particularly favourable to parasitic growth. Thus, also, we can explain the tendency of cancer to run in families, and to occur after middle life.

The comparative infrequency of the malignant growths is not, in my belief, due to the rarity of the parasites causing them, but to the happy infrequency of soil favourable to the growth of the parasite; and this fact must be borne in mind in attempts at inoculation, and although all such attempts have failed, let it be remembered (a fact which is apt to be forgotten) that this failure is equally difficult of explanation, whether the parasitic theory stand or fall, for certain it is that the body inoculates itself. I say the tendency to malignant disease is due to the power of growing the parasite, and not to the affected tissues having any particular and special tendency to undergo the malignant change, for I hold that the tissues of all alike possess these potentialities. Exemption from malignant disease depends, in fact, upon exemption from the evil cell-E, and this, again, upon some peculiar body state unfavourable to the bacterial cultivation, and not upon any inability of the tissues to take on malignant change should they be subjected to the necessary mal-E. The capacity to undergo malignant dissolution belongs to all vertebrates: all possess the same potentialities, and what wonder? All the members of this vast kingdom are knit together under the one grand scheme of evolution. At every onward step there is divergence—a

change from the homogeneous to the heterogeneous, and the several members become more and more unlike one another; but, under the stimulus of bacterial irritation, there is dissolution, and the affected tissues revert to ground common to the whole class.

Wherefore I am led, on *à priori* grounds, to conclude that malignant disease is due to peculiarity of both S and E—peculiarity of S, as already set forth, and peculiarity of E in the shape of a specific parasite.

INDEX.

A

B

C

M

N

O

P

Q

R

S

PRINTED BY BALLANTYNE, HANSON AND CO.
LONDON AND EDINBURGH

October, 1888.

CATALOGUE OF WORKS

PUBLISHED BY

H. K. LEWIS

136 GOWER STREET, LONDON, W.C.

Established 1844.

SIR WILLIAM AITKEN, KNT., M.D., F.R.S.
Professor of Pathology in the Army Medical School.

ON THE ANIMAL ALKALOIDS, THE PTOMAINES, LEUCOMAINES, AND EXTRACTIVES IN THEIR PATHOLOGICAL RELATIONS. Crown 8vo, 2s. 6d.

E. CRESSWELL BABER, M.B. LOND.
Surgeon to the Brighton and Sussex Throat and Ear Dispensary.

A GUIDE TO THE EXAMINATION OF THE NOSE, WITH REMARKS ON THE DIAGNOSIS OF DISEASES OF THE NASAL CAVITIES. With Illustrations, small 8vo, 5s. 6d.

G. GRANVILLE BANTOCK, M.D., F.R.C.S. EDIN.
Surgeon to the Samaritan Free Hospital for Women and Children.

I.

ON THE USE AND ABUSE OF PESSARIES. Second Edit., with Illustrations, 8vo, 5s.

II.

ON THE TREATMENT OF RUPTURE OF THE FEMALE PERINEUM IMMEDIATE AND REMOTE. Second Edition, with Illustrations, 8vo, 3s. 6d. [*Just published.*

III.

A PLEA FOR EARLY OVARIOTOMY. Demy 8vo, 2s.

FANCOURT BARNES, M.D., M.R.C.P.
Physician to the Chelsea Hospital for Women; Obstetric Physician to the Great Northern Hospital, &c.

A GERMAN-ENGLISH DICTIONARY OF WORDS AND TERMS USED IN MEDICINE AND ITS COGNATE SCIENCES. Square 12mo, Roxburgh binding, 9s.

GURDON BUCK, M.D.

CONTRIBUTIONS TO REPARATIVE SURGERY: Showing its Application to the Treatment of Deformities, produced by Destructive Disease or Injury; Congenital Defects from Arrest or Excess of Development; and Cicatricial Contractions from Burns. Illustrated by numerous Engravings, large 8vo, 9s.

MARY BULLAR & J. F. BULLAR, M.B. CANTAB., F.R.C.S.

RECEIPTS FOR FLUID FOODS. 16mo, 1s.

DUDLEY W. BUXTON, M.D., B.S., M.R.C.P.

Administrator of Anæsthetics at University College Hospital and the Hospital for Women, Soho Square.

ANÆSTHETICS THEIR USES AND ADMINISTRATION. Crown 8vo, 4s. [*Ready.*

[LEWIS'S PRACTICAL SERIES.]

ALFRED H. CARTER, M.D. LOND.

Member of the Royal College of Physicians; Physician to the Queen's Hospital, Birmingham; Examiner in Medicine for the University of Aberdeen, &c.

ELEMENTS OF PRACTICAL MEDICINE. Fifth Edition, crown 8vo, 9s. [*Just published.*

P. CAZEAUX.

Adjunct Professor in the Faculty of Medicine of Paris, &c.

AND

S. TARNIER.

Professor of Obstetrics and Diseases of Women and Children in the Faculty of Medicine of Paris.

OBSTETRICS: THE THEORY AND PRACTICE; including the Diseases of Pregnancy and Parturition, Obstetrical Operations, &c. Seventh Edition, edited and revised by ROBERT J. HESS, M.D., with twelve full-page plates, five being coloured, and 165 wood-engravings, 1081 pages, roy. 8vo, 35s.

FRANCIS HENRY CHAMPNEYS, M.A., M.B. OXON., F.R.C.P.

Obstetric Physician and Lecturer on Obstetric Medicine at St. George's Hospital: Examiner in Obstetric Medicine in the University of London, &c.

EXPERIMENTAL RESEARCHES IN ARTIFICIAL RESPIRATION IN STILLBORN CHILDREN, AND ALLIED SUBJECTS. Crown 8vo, 3s. 6d.

W. BRUCE CLARKE, M.A., M.B. OXON., F.R.C.S.

Assistant Surgeon to, and Senior Demonstrator of Anatomy and Operative Surgery at, St. Bartholomew's Hospital; Surgeon to the West London Hospital; Examiner in Surgery to the University of Oxford.

THE DIAGNOSIS AND TREATMENT OF DISEASES OF THE KIDNEY AMENABLE TO DIRECT SURGICAL INTERFERENCE. Demy 8vo, with Illustrations, 7s. 6d.

JOHN COCKLE, M.A., M.D.
Physician to the Royal Free Hospital.

ON INTRA-THORACIC CANCER. 8vo, 4s. 6d.

ALEXANDER COLLIE, M.D. ABERD., M.R.C.P. LOND.
Medical Superintendent of the Eastern Hospitals.

ON FEVERS: THEIR HISTORY, ETIOLOGY, DIAG-NOSIS, PROGNOSIS, AND TREATMENT. Illustrated with Coloured Plates, crown 8vo, 8s. 6d. [LEWIS'S PRACTICAL SERIES.]

WALTER S. COLMAN, M.B. LOND.
Formerly Assistant to the Professor of Pathology in the University of Edinburgh.

SECTION CUTTING AND STAINING: A Practical Guide to the Preparation of Normal and Morbid Histological Specimens. [*In the press.*

ALFRED COOPER, F.R.C.S.
Surgeon to the St. Mark's Hospital for Fistula and other Diseases of the Rectum.

A PRACTICAL TREATISE ON THE DISEASES OF THE RECTUM. Crown 8vo, 4s. [*Just published.*

W. H. CORFIELD, M.A., M.D. OXON.
Professor of Hygiene and Public Health in University College, London.

DWELLING HOUSES: their Sanitary Construction and Arrangements. Second Edit., with Illustrations. Cr. 8vo, 3s. 6d.

EDWARD COTTERELL, M.R.C.S. ENG., L.R.C.P. LOND.
Late House Surgeon, University College Hospital.

ON SOME COMMON INJURIES TO LIMBS; their Treatment and After-treatment, including Bone-setting (so-called). With Illustrations, small 8vo, 3s. 6d.

CHARLES CREIGHTON, M.D.

I.

ILLUSTRATIONS OF UNCONSCIOUS MEMORY IN DISEASE, including a Theory of Alteratives. Post 8vo, 6s.

II.

CONTRIBUTIONS TO THE PHYSIOLOGY AND PATHOLOGY OF THE BREAST AND LYMPHATIC GLANDS. New Edition with additional chapter, with wood-cuts and plate, 8vo, 9s.

III.

BOVINE TUBERCULOSIS IN MAN: An Account of the Pathology of Suspected Cases. With Chromo-lithographs and other Illustrations, 8vo, 8s. 6d.

H. RADCLIFFE CROCKER, M.D. LOND., B.S., F.R.C.P.
Physician, Skin Department, University College Hospital.

A TREATISE ON DISEASES OF THE SKIN AND THEIR TREATMENT. With 76 Illustrations, 8vo, 21s. [*Now ready.*

EDGAR M. CROOKSHANK, M.B. LOND., F.R.M.S.
Professor of Bacteriology, King's College, London.

I.

MANUAL OF BACTERIOLOGY: being an Introduction to Practical Bacteriology. Illustrated with Coloured Plates from original drawings, and numerous Coloured Illustrations embodied in the text. Second Edition revised and enlarged, 8vo, 21s.

II.

PHOTOGRAPHY OF BACTERIA. Illustrated with 86 Photographs reproduced in autotype, and wood engravings, royal 8vo, 12s. 6d.

RIDLEY DALE, M.D., L.R.C.P. EDIN., M.R.C.S. ENG.

EPITOME OF SURGERY. Large 8vo. [*In the press.*

HENRY DAVIS, M.R.C.S. ENG.
Teacher and Administrator of Anæsthetics to St. Mary's and the National Dental Hospitals.

GUIDE TO THE ADMINISTRATION OF ANÆSTHE-TICS. Fcap. 8vo, 2s.

A. DE WATTEVILLE, M.A., M.D., B.SC., M.R.C.S.
Physician in Charge of the Electro-therapeutical Department at St. Mary's Hospital.

A PRACTICAL INTRODUCTION TO MEDICAL ELECTRICITY. Second Edition, re-written and enlarged, copiously Illustrated, 8vo, 9s.

J. THOMPSON DICKSON, M.A., M.B. CANTAB.
Late Lecturer on Mental Diseases at Guy's Hospital.

THE SCIENCE AND PRACTICE OF MEDICINE IN RELATION TO MIND, the Pathology of the Nerve Centres, and the Jurisprudence of Insanity, being a course of Lectures delivered at Guy's Hospital. Illustrated by Chromo-lithographic Drawings and Physiological Portraits. 8vo, 14s.

HORACE DOBELL, M.D.

Consulting Physician to the Royal Hospital for Diseases of the Chest, &c.

I.

ON DIET AND REGIMEN IN SICKNESS AND Health and on the Interdependence and Prevention of Diseases and the Diminution of their Fatality. Seventh Edition, 8vo, 10s. 6d.

II.

AFFECTIONS OF THE HEART AND IN ITS NEIGH-BOURHOOD. Cases, Aphorisms, and Commentaries. Illustrated by the heliotype process. 8vo, 6s 6d.

JOHN EAGLE.

Member of the Pharmaceutical Society.

A NOTE-BOOK OF SOLUBILITIES. Arranged chiefly for the use of Prescribers and Dispensers. 12mo, 2s. 6d.

JOHN ERIC ERICHSEN.

Ex-President of the Royal College of Surgeons; Surgeon Extraordinary to H.M. the Queen, etc.

MODERN SURGERY; its Progress and Tendencies. Being the Introductory Address delivered at University College at the opening of the Session 1873-74. Demy 8vo, 1s.

DR. FERBER.

MODEL DIAGRAM OF THE ORGANS IN THE THORAX AND UPPER PART OF THE ABDOMEN. With Letter-press Description. In 4to, coloured, 5s.

J. MAGEE FINNY, M.D. DUBL.

King's Professor of Practice of Medicine in School of Physic, Ireland; Clinical Physician to St. Patrick Dun's Hospital.

NOTES ON THE PHYSICAL DIAGNOSIS OF LUNG DISEASES. 32mo, 1s. 6d. [*Now ready.*

AUSTIN FLINT, JR., M.D.

Professor of Physiology and Physiological Anatomy in the Bellevue Medical College, New York; attending Physician to the Bellevue Hospital, &c.

I.

A TEXT-BOOK OF HUMAN PHYSIOLOGY; De-signed for the Use of Practitioners and Students of Medicine. New edition, Illustrated by plates, and 313 wood engravings, large 8vo, 28s.

II.

THE PHYSIOLOGY OF THE SPECIAL SENSES AND GENERATION; (Being Vol. V. of the Physiology of Man). Roy. 8vo, 18s.

J. MILNER FOTHERGILL, M.D.

Member of the Royal College of Physicians of London; Physician to the City of London Hospital for Diseases of the Chest, Victoria Park, &c.

I.

A MANUAL OF DIETETICS: Large 8vo, 10s. 6d.

II.

THE HEART AND ITS DISEASES, WITH THEIR TREATMENT; INCLUDING THE GOUTY HEART. Second Edition, entirely re-written, copiously illustrated with woodcuts and lithographic plates. 8vo. 16s.

III.

INDIGESTION AND BILIOUSNESS. Second Edition, post 8vo, 7s. 6d.

IV.

GOUT IN ITS PROTEAN ASPECTS. Post 8vo, 7s. 6d.

V.

HEART STARVATION. (Reprinted from the Edinburgh Medical Journal), 8vo, 1s.

ERNEST FRANCIS, F.C.S.

Demonstrator of Practical Chemistry, Charing Cross Hospital.

PRACTICAL EXAMPLES IN QUANTITATIVE ANA-lysis, forming a Concise Guide to the Analysis of Water, &c. Illustrated, fcap. 8vo, 2s. 6d.

ALFRED W. GERRARD, F.C.S.

Examiner to the Pharmaceutical Society; Teacher of Pharmacy and Demonstrator of Materia Medica at University College Hospital.

ELEMENTS OF MATERIA MEDICA AND PHAR-MACY. Crown 8vo, 8s. 6d. [*Just published.*

HENEAGE GIBBES, M.D.

Lecturer on Physiology and on Normal and Morbid Histology in the Medical School of Westminster Hospital; etc.

PRACTICAL HISTOLOGY AND PATHOLOGY. Third Edition, revised and enlarged, crown 8vo, 6s.

C. A. GORDON, M.D., C.B.

Deputy Inspector General of Hospitals, Army Medical Department.

REMARKS ON ARMY SURGEONS AND THEIR WORKS. Demy 8vo, 5s.

JOHN GORHAM, M.R.C.S.

TOOTH EXTRACTION: a Manual on the proper mode of extracting Teeth. Second Edition, fcap. 8vo, 1s.

JOHN W. S. GOULEY, M.D.

Surgeon to Bellevue Hospital.

DISEASES OF MAN: Data of their Nomenclature, Classification and Genesis. Crown 8vo, 14s.

W. R. GOWERS, M.D., F.R.C.P., M.R.C.S.

Physician to University College Hospital, &c.

DIAGRAMS FOR THE RECORD OF PHYSICAL SIGNS. In books of 12 sets of figures, 1s. Ditto, unbound, 1s.

J. B. GRESSWELL, M.R.C.V.S.

Provincial Veterinary Surgeon to the Royal Agricultural Society.

VETERINARY PHARMACOLOGY AND THERAPEUTICS. With an Index of Diseases and Remedies. Fcap. 8vo, 5s.

SAMUEL D. GROSS, M.D., LL.D., D.C.L. OXON.

Professor of Surgery in the Jefferson Medical College of Philadelphia.

A PRACTICAL TREATISE ON THE DISEASES, INJURIES, AND MALFORMATIONS OF THE URINARY BLADDER, THE PROSTATE GLAND, AND THE URETHRA. Third Edition, revised and edited by S. W. GROSS, A.M., M.D., Surgeon to the Philadelphia Hospital. Illustrated by 170 engravings, 8vo, 18s.

SAMUEL W. GROSS, A.M., M.D.

Surgeon to, and Lecturer on Clinical Surgery in, the Jefferson Medical College Hospital, and the Philadelphia Hospital, &c.

A PRACTICAL TREATISE ON TUMOURS OF THE MAMMARY GLAND: embracing their Histology, Pathology, Diagnosis, and Treatment. With Illustrations, 8vo, 10s. 6d.

ALLAN McLANE HAMILTON, M.D.

THE MODERN TREATMENT OF HEADACHES. Square 16mo, 2s. 6d. [*Just published.*

WILLIAM A. HAMMOND, M.D.
Professor of Mental and Nervous Diseases in the Medical Department of the University of the City of New York, &c.

I.

A TREATISE ON THE DISEASES OF THE NERVOUS SYSTEM. Seventh edition, with 112 Illustrations, large 8vo, 25s.

II.

A TREATISE ON INSANITY. Large 8vo, 25s.

III.

SPIRITUALISM AND ALLIED CAUSES AND CONDITIONS OF NERVOUS DERANGEMENT. With Illustrations, post 8vo. 8s. 6d.

ALEXANDER HARVEY, M.A., M.D.
Emeritus Professor of Materia Medica in the University of Aberdeen; Consulting Physician to the Aberdeen Royal Infirmary, &c.

I.

FIRST LINES OF THERAPEUTICS; as based on the Modes and the Processes of Healing, as occurring Spontaneously in Disease; and on the Modes and the Processes of Dying, as resulting Naturally from Disease. In a series of Lectures. Post 8vo, 5s.

II.

ON THE FŒTUS IN UTERO AS INOCULATING THE MATERNAL WITH THE PECULIARITIES OF THE PATERNAL ORGANISM. In a series of Essays now first collected. Fcap. 8vo, 4s. 6d.

ALEXANDER HARVEY, M.D.
Emeritus Professor of Materia Medica in the University of Aberdeen, &c.

AND

ALEXANDER DYCE DAVIDSON, M.D., F.R.S. EDIN.
Late Regius Professor of Materia Medica in the University of Aberdeen.

SYLLABUS OF MATERIA MEDICA FOR THE USE OF STUDENTS, TEACHERS AND PRACTITIONERS Based on the relative values of articles and preparations in the British Pharmacopœia. Eighth Edition, 32mo, 1s. 6d.

K. M. HEANLEY.

Matron of Boston Cottage Hospital.

A MANUAL OF URINE TESTING. Compiled for the use of Matrons, Nurses, and Probationers. Post 8vo, 1s. 6d.

GRAILY HEWITT, M.D.

Professor of Midwifery and Diseases of Women in University College, Obstetrical Physician to University College Hospital, &c.

OUTLINES OF PICTORIAL DIAGNOSIS OF DISEASES OF WOMEN. Folio, 6s.

C. HIGGENS, F.R.C.S.

Ophthalmic Surgeon to Guy's Hospital; Lecturer on Ophthalmology at Guy's Hospital Medical School.

MANUAL OF OPHTHALMIC PRACTICE.
Crown 8vo. [*Just ready.*
[LEWIS'S PRACTICAL SERIES.]

BERKELEY HILL, M.B. LOND., F.R.C.S.

Professor of Clinical Surgery in University College; Surgeon to University College Hospital and to the Lock Hospital.

THE ESSENTIALS OF BANDAGING. With directions for Managing Fractures and Dislocations; for administering Ether and Chloroform; and for using other Surgical Apparatus; with a Chapter on Surgical Landmarks. Sixth Edition, revised and enlarged, Illustrated by 144 Wood Engravings, crown 8vo, 5s.

BERKELEY HILL, M.B. LOND., F.R.C.S.

Professor of Clinical Surgery in University College; Surgeon to University College Hospital and to the Lock Hospital.

AND

ARTHUR COOPER, L.R.C.P., M.R.C.S.

Surgeon to the Westminster General Dispensary.

I.

SYPHILIS AND LOCAL CONTAGIOUS DISORDERS. Second Edition, entirely re-written, royal 8vo, 18s.

II.

THE STUDENT'S MANUAL OF VENEREAL DISEASES. Being a Concise Description of those Affections and of their Treatment. Fourth Edition, post 8vo, 2s. 6d.

C. R. ILLINGWORTH, M.D. ED., M.R.C.S.

THE ABORTIVE TREATMENT OF SPECIFIC FEBRILE DISORDERS BY THE BINIODIDE OF MERCURY. Crown 8vo, 3s. 6d.

SIR W. JENNER, Bart., M.D.

Physician in Ordinary to H.M. the Queen, and to H.R.H. the Prince of Wales.

THE PRACTICAL MEDICINE OF TO-DAY: Two Addresses delivered before the British Medical Association, and the Epidemiological Society, (1869). Small 8vo, 1s. 6d.

C. M. JESSOP, M.R.C.P.

Associate of King's College, London; Brigade Surgeon H.M. British Forces.

ASIATIC CHOLERA, being a Report on an Outbreak of Epidemic Cholera in 1876 at a Camp near Murree in India. With map, demy 8vo, 2s. 6d.

GEORGE LINDSAY JOHNSON, M.A., M.B., B.C. CANTAB.

Clinical Assistant, late House Surgeon and Chloroformist, Royal Westminster Ophthalmic Hospital, &c.

A NEW METHOD OF TREATING CHRONIC GLAUCOMA, based on Recent Researches into its Pathology. With Illustrations and coloured frontispiece, demy 8vo, 3s. 6d.

NORMAN KERR, M.D., F.L.S.

President of the Society for the Study of Inebriety; Consulting Physician, Dalrymple Home for Inebriates, etc.

INEBRIETY: its Etiology, Pathology, Treatment, and Jurisprudence. Crown 8vo, 12s. 6d. [*Just published.*

RUSTOMJEE NASERWANJEE KHORY, M.D. BRUX.

Member of the Royal College of Physicians.

THE PRINCIPLES AND PRACTICE OF MEDICINE. Second Edition, revised and much enlarged, 2 vols., large 8vo, 28s.

NORMAN W. KINGSLEY, M.D.S., D.D.S.

President of the Board of Censors of the State of New York; Member of the American Academy of Dental Science, &c.

A TREATISE ON ORAL DEFORMITIES AS A BRANCH OF MECHANICAL SURGERY. With over 350 Illustrations, 8vo, 16s.

E. A. KIRBY, M.D., M.R.C.S. ENG.

Late Physician to the City Dispensary.

I.

A PHARMACOPŒIA OF SELECTED REMEDIES, WITH THERAPEUTIC ANNOTATIONS, Notes on Alimentation in Disease, Air, Massage, Electricity and other Supplementary Remedial Agents, and a Clinical Index; arranged as a Handbook for Prescribers. Sixth Edition, enlarged and revised, demy 4to, 7s.

II.

ON THE VALUE OF PHOSPHORUS AS A REMEDY FOR LOSS OF NERVE POWER. Sixth Edition, 8vo, 2s. 6d.

J. WICKHAM LEGG, F.R.C.P.

Assistant Physician to Saint Bartholomew's Hospital, and Lecturer on Pathological Anatomy in the Medical School.

I.

ON THE BILE, JAUNDICE, AND BILIOUS DISEASES. With Illustrations in chromo-lithography, 719 pages, roy. 8vo, 25s.

II.

A GUIDE TO THE EXAMINATION OF THE URINE; intended chiefly for Clinical Clerks and Students. Sixth Edition, revised and enlarged, with Illustrations, fcap. 8vo, 2s. 6d.

III.

A TREATISE ON HÆMOPHILIA, SOMETIMES CALLED THE HEREDITARY HÆMORRHAGIC DIATHESIS. Fcap. 4to, 7s. 6d.

ARTHUR H. N. LEWERS, M.D. LOND., M.R.C.P. LOND.

Assistant Obstetric Physician to the London Hospital; Examiner in Midwifery and Diseases of Women to the Society of Apothecaries of London; Physician to Out-patients at the Queen Charlotte's Lying-in Hospital, etc,

A PRACTICAL TEXTBOOK OF THE DISEASES OF WOMEN. With Illustrations, crown 8vo, 8s. 6d. [*Now ready.*

[LEWIS'S PRACTICAL SERIES.]

DR. GEORGE LEWIN.

Professor at the Fr. Wilh. University, and Surgeon-in-Chief of the Syphilitic Wards and Skin Disease Wards of the Charité Hospital, Berlin.

THE TREATMENT OF SYPHILIS WITH SUBCUTA-NEOUS SUBLIMATE INJECTIONS. Translated by DR. CARL PRŒGLE, and DR. E. H. GALE, late Surgeon United States Army. Small 8vo, 7s.

LEWIS'S PRACTICAL SERIES.

Under this title Mr. LEWIS is publishing a Series of Monographs, embracing the various branches of Medicine and Surgery.

The volumes are written by well-known Hospital Physicians and Surgeons, recognized as authorities in the subjects of which they treat. The works are intended to be of a THOROUGHLY PRACTICAL nature, calculated to meet the requirements of the practitioner and student, and to present the most recent information in a compact and readable form.

MANUAL OF OPHTHALMIC PRACTICE.
By C. HIGGENS, F.R.C.S., Ophthalmic Surgeon to Guy's Hospital; Lecturer on Ophthalmology at Guy's Hospital Medical School. With Illustrations, crown 8vo. [*Nearly ready.*

A PRACTICAL TEXTBOOK OF THE DISEASES OF WOMEN.
By ARTHUR H. N. LEWERS, M.D. Lond., M.R.C.P. Lond., Assistant Obstetric Physician to the London Hospital; Examiner in Midwifery and Diseases of Women to the Society of Apothecaries of London; Physician to Out-patients at the Queen Charlotte's Lying-in Hospital, etc. With Illustrations, crown 8vo, 8s. 6d. [*Ready.*

ANÆSTHETICS THEIR USES AND ADMINISTRATION.
By DUDLEY W. BUXTON, M.D., B S., M.R.C.P., Administrator of Anæsthetics in University College Hospital and the Hospital for Women, Soho Square. Crown 8vo, 4s. [*Ready.*

TREATMENT OF DISEASE IN CHILDREN: INCLUDING THE OUTLINES OF DIAGNOSIS AND THE CHIEF PATHOLOGICAL DIFFERENCES BETWEEN CHILDREN AND ADULTS. By ANGEL MONEY, M.D., M.R.C.P., Assistant Physician to the Hospital for Children, Great Ormond Street, and to University College Hospital. Crown 8vo, 10s. 6d.

ON FEVERS: THEIR HISTORY, ETIOLOGY, DIAGNOSIS, PROGNOSIS, AND TREATMENT. By ALEXANDER COLLIE, M.D. Aberd., Member of the Royal College of Physicians of London; Medical Superintendent of the Eastern Hospitals; Secretary of the Epidemiological Society for Germany and Russia. Illustrated with Coloured Plates, crown 8vo, 8s. 6d.

HANDBOOK OF DISEASES OF THE EAR FOR THE USE OF STUDENTS AND PRACTITIONERS. By URBAN PRITCHARD, M.D. Edin., F.R.C.S. Eng., Professor of Aural Surgery at King's College, London; Aural Surgeon to King's College Hospital; Senior Surgeon to the Royal Ear Hospital. With Illustrations, crown 8vo, 4s. 6d.

A PRACTICAL TREATISE ON DISEASES OF THE KIDNEYS AND URINARY DERANGEMENTS. By CHARLES HENRY RALFE, M.A., M.D. Cantab., Fellow of the Royal College of Physicians, London; Assistant Physician to the London Hospital; Examiner in Medicine to the University of Durham, etc., etc. With Illustrations, crown 8vo, 10s. 6d.

DENTAL SURGERY FOR GENERAL PRACTITIONERS AND STUDENTS OF MEDICINE. By ASHLEY W. BARRETT, M.B. Lond., M.R.C.S., L.D.S., Dental Surgeon to, and Lecturer on Dental Surgery and Pathology in the Medical School of, the London Hospital. With Illustrations, cr. 8vo, 3s.

BODILY DEFORMITIES AND THEIR TREATMENT: A HANDBOOK OF PRACTICAL ORTHOPÆDICS. By H. A. REEVES, F.R.C.S. Edin., Senior Assistant Surgeon and Teacher of Practical Surgery at the London Hospital; Surgeon to the Royal Orthopædic Hospital, &c. With numerous Illustrations, cr. 8vo, 8s. 6d.

Further volumes will be announced in due course.

LEWIS'S POCKET CASE BOOK FOR PRACTITIONERS AND STUDENTS. Designed by A. T. BRAND, M.D. Roan, with pencil, 3s. 6d. *nett.*

LEWIS'S POCKET MEDICAL VOCABULARY. Over 200 pp., 32mo, roan, 3s. 6d.

T. R. LEWIS, M.B., F.R.S. ELECT, ETC.
Late Fellow of the Calcutta University, Surgeon-Major Army Medical Staff, etc.

PHYSIOLOGICAL AND PATHOLOGICAL RESEARCHES. Arranged and edited by SIR WM. AITKEN, M.D., F.R.S., G. E. DOBSON, M.B., F.R.S., and A. E. BROWN, B.Sc. Crown 4to, portrait, 5 maps, 43 plates including 15 chromo-lithographs, and 67 wood engravings, 30s. *nett.* [*Just published.*

J. S. LOMBARD, M.D.
Formerly Assistant Professor of Physiology in Harvard College.

I.

EXPERIMENTAL RESEARCHES ON THE REGIONAL TEMPERATURE OF THE HEAD, under Conditions of Rest, Intellectual Activity and Emotion. With Illustrations, 8vo, 8s.

II.

ON THE NORMAL TEMPERATURE OF THE HEAD. 8vo, 5s.

WILLIAM THOMPSON LUSK, A.M., M.D.
Professor of Obstetrics and Diseases of Women in the Bellevue Hospital Medical College, &c.

THE SCIENCE AND ART OF MIDWIFERY. Third Edition, with numerous Illustrations, 8vo, 18s.

RAWDON MACNAMARA.
Professor of Materia Medica Royal College of Surgeons, Ireland; Senior Surgeon to the Westmoreland (Lock) Government Hospital; Surgeon to the Meath Hospital, etc.

AN INTRODUCTION TO THE STUDY OF THE BRITISH PHARMACOPŒIA. Demy 32mo, 1s. 6d. [*Just published*

JOHN MACPHERSON, M.D.
Inspector-General of Hospitals H.M. Bengal Army (Retired).
Author of "Cholera in its Home," &c.

I.

ANNALS OF CHOLERA FROM THE EARLIEST PERIODS TO THE YEAR 1817. With a map. Demy 8vo, 7s. 6d.

II.

BATH, CONTREXEVILLE, AND THE LIME SULPHATED WATERS. Crown 8vo, 2s. 6d.

Wm. JULIUS MICKLE, M.D., F.R.C.P. LOND.

Medical Superintendent, Grove Hall Asylum, London, &c.

I.

GENERAL PARALYSIS OF THE INSANE. Second Edition, enlarged and rewritten, 8vo, 14s.

II.

ON INSANITY IN RELATION TO CARDIAC AND AORTIC DISEASE AND PHTHISIS. Crown 8vo, 3s. 6d.

KENNETH W. MILLICAN, B.A. CANTAB., M.R.C.S.

THE EVOLUTION OF MORBID GERMS: A Contribu-bution to Transcendental Pathology. Cr. 8vo, 3s. 6d.

ANGEL MONEY, M.D., M.R.C.P.

Assistant Physician to the Hospital for Children, Great Ormond Street, and to University College Hospital.

TREATMENT OF DISEASE IN CHILDREN: IN-CLUDING THE OUTLINES OF DIAGNOSIS AND THE CHIEF PATHOLOGICAL DIFFERENCES BETWEEN CHILDREN AND ADULTS. Crown 8vo, 10s. 6d.

[LEWIS'S PRACTICAL SERIES.]

E. A. MORSHEAD, M.R.C.S., L.R.C.P.

Assistant to the Professor of Medicine in University College, London.

TABLES OF THE PHYSIOLOGICAL ACTION OF DRUGS. Fcap. 8vo, 1s.

A. STANFORD MORTON, M.B., F.R.C.S. ED.

Surgeon to the Royal South London Ophthalmic Hospital.

REFRACTION OF THE EYE: Its Diagnosis, and the Correction of its Errors. Third Edition, with Illustrations, small 8vo. 3s.

C. W. MANSELL MOULLIN, M.A., M.D. OXON., F.R.C.S. ENG.

Assistant Surgeon and Senior Demonstrator of Anatomy at the London Hospital; formerly Radcliffe Travelling Fellow and Fellow of Pembroke College, Oxford.

SPRAINS; THEIR CONSEQUENCES AND TREATMENT. Crown 8vo, 5s. [*Now ready.*

PAUL F. MUNDÉ, M.D.

Professor of Gynecology at the New York Polyclinic; President of the New York Obstetrical Society and Vice-President of the British Gynecological Society, &c.

THE MANAGEMENT OF PREGNANCY, PARTURITION, AND THE PUERPERAL STATE, NORMAL AND ABNORMAL. Square 8vo, 3s. 6d. [*Just published.*

WILLIAM MURRELL, M.D., F.R.C.P.

Lecturer on Materia Medica and Therapeutics at Westminster Hospital; Examiner in Materia Medica to the Royal College of Physicians of London, etc.

MASSAGE AS A MODE OF TREATMENT. Third Edit., with Illustrations, crown 8vo, 4s. 6d. [*Just published.*

II.

WHAT TO DO IN CASES OF POISONING. Fifth Edition, royal 32mo, 3s. 6d.

III.

NITRO-GLYCERINE AS A REMEDY FOR ANGINA PECTORIS. Crown 8vo, 3s. 6d.

DR. FELIX von NIEMEYER.

Late Professor of Pathology and Therapeutics; Director of the Medical Clinic of the University of Tübingen.

A TEXT-BOOK OF PRACTICAL MEDICINE, WITH PARTICULAR REFERENCE TO PHYSIOLOGY AND PATHOLOGICAL ANATOMY. Translated from the Eighth German Edition, by special permission of the Author, by GEORGE H. HUMPHREY, M.D., and CHARLES E. HACKLEY, M.D. Revised Edition, 2 vols., large 8vo, 36s.

GEORGE OLIVER, M.D., F.R.C.P.

I.

THE HARROGATE WATERS: Data Chemical and Therapeutical, with notes on the Climate of Harrogate. Addressed to the Medical Profession. Crown 8vo, with Map of the Wells, 3s. 6d.

II.

ON BEDSIDE URINE TESTING: a Clinical Guide to the Observation of Urine in the course of Work. Third Edition, revised and enlarged, fcap. 8vo, 3s. 6d.

SAMUEL OSBORN, F.R.C.S.

Assistant-Surgeon to the Hospital for Women; Surgeon Royal Naval Artillery Volunteers.

I.

AMBULANCE LECTURES: FIRST AID. With Illustrations, fcap. 8vo, 1s. 6d.

II.

AMBULANCE LECTURES: NURSING. With Illustrations fcap. 8vo, 1s. 6d.

ROBERT W. PARKER.

Surgeon to the East London Hospital for Children, and to the Grosvenor Hospital for Women and Children.

I.

TRACHEOTOMY IN LARYNGEAL DIPHTHERIA, AFTER TREATMENT AND COMPLICATIONS. Second Edition. With Illustrations, 8vo, 5s.

II.

CONGENITAL CLUB-FOOT; ITS NATURE AND TREATMENT. With special reference to the subcutaneous division of Tarsal Ligaments. 8vo, 7s. 6d.

JOHN S. PARRY, M.D.

Obstetrician to the Philadelphia Hospital, Vice-President of the Obstetrical and Pathological Societies of Philadelphia, &c.

EXTRA-UTERINE PREGNANCY; Its Causes, Species, Pathological Anatomy, Clinical History, Diagnosis, Prognosis and Treatment. 8vo, 8s.

E. RANDOLPH PEASLEE, M.D., LL.D.

Late Professor of Gynæcology in the Medical Department of Dartmouth College; President of the New York Academy of Medicine, &c., &c.

OVARIAN TUMOURS: Their Pathology, Diagnosis, and Treatment, especially by Ovariotomy. Illustrations, roy. 8vo, 16s.

G. V. POORE, M.D., F.R.C.P.

Professor of Medical Jurisprudence, University College; Assistant Physician to, and Physician in charge of the Throat Department of, University College Hospital.

LECTURES ON THE PHYSICAL EXAMINATION OF THE MOUTH AND THROAT. With an Appendix of Cases. 8vo, 3s. 6d.

R. DOUGLAS POWELL, M.D., F.R.C.P., M.R.C.S.

Physician Extraordinary to H.M. the Queen; Physician to the Middlesex Hospital, and Physician to the Hospital for Consumption and Diseases of the Chest at Brompton.

DISEASES OF THE LUNGS AND PLEURÆ, INCLUD- ING CONSUMPTION. Third Edition, entirely rewritten and enlarged. With coloured plates and wood engravings, 8vo, 16s.

URBAN PRITCHARD, M.D. EDIN., F.R.C.S. ENG.

Professor of Aural Surgery at King's College, London; Aural Surgeon to King's College Hospital; Senior Surgeon to the Royal Ear Hospital.

HANDBOOK OF DISEASES OF THE EAR FOR THE USE OF STUDENTS AND PRACTITIONERS, With Illustrations, crown 8vo, 4s. 6d.

[[Lewis's Practical Series.]

CHARLES W. PURDY, M.D. (QUEEN'S UNIV.)

Professor of Genito-Urinary and Renal Diseases in the Chicago Polyclinic, &c., &c.

BRIGHT'S DISEASE AND THE ALLIED AFFECTIONS OF THE KIDNEYS. With Illustrations, large 8vo, 8s. 6d.

CHARLES HENRY RALFE, M.A., M.D. CANTAB., F.R.C.P. LOND.
Assistant Physician to the London Hospital; Examiner in Medicine to the University of Durham, etc., etc.

A PRACTICAL TREATISE ON DISEASES OF THE KIDNEYS AND URINARY DERANGEMENTS. With Illustrations, crown 8vo, 10s. 6d.

[LEWIS'S PRACTICAL SERIES.]

AMBROSE L. RANNEY, A.M., M.D.
Professor of the Anatomy and Physiology of the Nervous System in the New York Post-Graduate Medical School and Hospital; Professor of Nervous and Mental Diseases in the Medical Department of the University of Vermont.

THE APPLIED ANATOMY OF THE NERVOUS SYS-TEM. Being a Study of this portion of the Human Body from a stand-point of its general interest and practical utility in Diagnosis, designed for use as a text-book and a work of reference. Second Edit., 238 Illustrations, large 8vo, 21s. [*Just published.*

H. A. REEVES, F.R.C.S. EDIN.
Senior Assistant Surgeon and Teacher of Practical Surgery at the London Hospital; Surgeon to the Royal Orthopædic Hospital.

BODILY DEFORMITIES AND THEIR TREATMENT: A HANDBOOK OF PRACTICAL ORTHOPÆDICS. With numerous Illustrations, crown 8vo, 8s. 6d.

[LEWIS'S PRACTICAL SERIES.]

RALPH RICHARDSON, M.A., M.D.
Fellow of the College of Physicians, Edinburgh.

ON THE NATURE OF LIFE: An Introductory Chap-ter to Pathology. Second Edition, revised and enlarged. Fcap. 4to, 10s. 6d.

W. RICHARDSON, M.A., M.D., M.R.C.P.

REMARKS ON DIABETES, ESPECIALLY IN REFER-ENCE TO TREATMENT. Demy 8vo, 4s. 6d.

SYDNEY RINGER, M.D., F.R.S.
Professor of the Principles and Practice of Medicine in University College; Physician to, and Professor of Clinical Medicine in, University College Hospital.

I.

A HANDBOOK OF THERAPEUTICS. Twelfth Edition, thoroughly revised, 8vo, 15s. [*Just ready.*

II.

ON THE TEMPERATURE OF THE BODY AS A MEANS OF DIAGNOSIS AND PROGNOSIS IN PHTHISIS. Second Edition, small 8vo, 2s. 6d.

FREDERICK T. ROBERTS, M.D., B.SC., F.R.C.P.

Examiner in Medicine at the Royal College of Surgeons; Professor of Therapeutics in University College; Physician to University College Hospital; Physician to Brompton Consumption Hospital, &c.

I.

A HANDBOOK OF THE THEORY AND PRACTICE OF MEDICINE. Seventh Edition, with Illustrations, in one volume, large 8vo, 21s. [*Just published.*

**** Copies may also be had bound in two volumes cloth for 1s. 6d. extra.*

II.

THE OFFICINAL MATERIA MEDICA.
Second Edition, entirely rewritten in accordance with the latest British Pharmacopœia, fcap. 8vo, 7s. 6d.

R. LAWTON ROBERTS, M.D., M.R.C.S.

ILLUSTRATED LECTURES ON AMBULANCE WORK.
Third Edition, copiously Illustrated, crown 8vo, 2s. 6d. [*Just ready.*

A. R. ROBINSON, M.B., L.R.C.P., AND L.R.C.S. EDIN.

Professor of Dermatology at the New York Polyclinic.

A MANUAL OF DERMATOLOGY. With 88 Illustrations, large 8vo, 21s.

D. B. St. JOHN ROOSA, M.A., M.D.

Professor of Diseases of the Eye and Ear in the University of the City of New York; Surgeon to the Manhattan Eye and Ear Hospital; Consulting Surgeon to the Brooklyn Eye and Ear Hospital, &c., &c.

A PRACTICAL TREATISE ON THE DISEASES OF THE EAR, including the Anatomy of the Organ. Sixth Edition, Illustrated by wood engravings and chromo-lithographs, large 8vo, 25s.

ROBSON ROOSE, M.D.

Fellow of the Royal College of Physicians in Edinburgh.

I.

GOUT, AND ITS RELATIONS TO DISEASES OF THE LIVER AND KIDNEYS. Fifth Edition, crown 8vo, 3s. 6d.

II.

NERVE PROSTRATION AND OTHER FUNCTIONAL DISORDERS OF DAILY LIFE. Crown 8vo, 10s. 6d.
[*Just published.*

J. BURDON SANDERSON, M.D., LL.D., F.R.S.

Jodrell Professor of Physiology in University College, London.

UNIVERSITY COLLEGE COURSE OF PRACTICAL EXERCISES IN PHYSIOLOGY. With the co-operation of F. J. M. PAGE, B.Sc., F.C.S.; W. NORTH, B.A., F.C.S., and AUG. WALLER, M.D. Demy 8vo, 3s. 6d.

W. H. O. SANKEY, M.D. LOND., F.R.C.P.

Late Lecturer on Mental Diseases, University College and School of Medicine for Women, London; Formerly Medical Superintendent (Female Department) of Hanwell Asylum; President of Medico-Psychological Society, &c.

LECTURES ON MENTAL DISEASE. Second Edition, with coloured plates, 8vo, 12s. 6d.

JOHN SAVORY.

Member of the Society of Apothecaries, London.

A COMPENDIUM OF DOMESTIC MEDICINE AND COMPANION TO THE MEDICINE CHEST: Intended as a source of easy reference for Clergymen, Master Mariners, and Travellers; and for Families resident at a distance from professional assistance. Tenth Edition, sm. 8vo, 5s. [*Now ready.*

DR. B. S. SCHULTZE.

Professor of Gynæcology; Director of the Lying-in Hospital and of the Gynæcologibal Clinic at Jena.

THE PATHOLOGY AND TREATMENT OF DIS- PLACEMENTS OF THE UTERUS. Translated by A. V. MACAN, B.A., M.B., Master of the Rotunda Lying-in Hospital, Dublin, and J. J. MACAN, M.A., M.R.C.S. With Illustrations, medium 8vo.
[*In the press.*

JOHN V. SHOEMAKER, A.M., M.D.
Professor of Skin Diseases in the Medico-Chirurgical College and Hospital of Philadelphia; Physician to the Philadelphia Hospital for Diseases of the Skin.

A PRACTICAL TREATISE ON DISEASES OF THE SKIN. Coloured Plates and other Illustrations, large 8vo, 24s.

WM. JAPP SINCLAIR, M.A., M.D.
Honorary Physician to the Manchester Southern Hospital for Women and Children, and Manchester Maternity Hospital.

ON GONORRHŒAL INFECTION IN WOMEN. Post 8vo, 4s. [*Just published.*

ALDER SMITH, M.B. LOND., F.R.C.S.
Resident Medical Officer, Christ's Hospital, London.

RINGWORM: Its Diagnosis and Treatment. Third Edition, enlarged, with Illustrations, fcap. 8vo, 5s. 6d.

J. LEWIS SMITH, M.D.
Physician to the New York Infants' Hospital; Clinical Lecturer on Diseases of Children in Bellevue Hospital Medical College.

A TREATISE ON THE DISEASES OF INFANCY AND CHILDHOOD. Fifth Edition, with Illustrations, large 8vo, 21s

---

FRANCIS W. SMITH, M.B., B.S.

THE SALINE WATERS OF LEAMINGTON. Second Edit., with Illustrations, crown 8vo, 1s. *nett.*

JAMES STARTIN, M.B., M.R.C.S.
Surgeon and Joint Lecturer to St. John's Hospital for Diseases of the Skin.

LECTURES ON THE PARASITIC DISEASES OF THE SKIN. VEGETOID AND ANIMAL. With Illustrations, crown 8vo, 2s. 6d.

LEWIS A. STIMSON, B.A., M.D.
Surgeon to the Presbyterian and Bellevue Hospitals; Professor of Clinical Surgery in the Medical Faculty of the University of the City of New York, &c.

A MANUAL OF OPERATIVE SURGERY. Second Edition, with three hundred and forty-two Illustrations, post 8vo, 10s. 6d. [*Just published.*

ADOLF STRÜMPELL.

Director of the Medical Clinic in the University of Erlangen.

A TEXT-BOOK OF MEDICINE FOR STUDENTS AND PRACTITIONERS. Translated from the latest German edition by Dr. H. F. Vickery and Dr. P. C. Knapp, with Editorial Notes by Dr. F. C. Shattuck, Visiting Physician to the Massachusetts General Hospital, etc. Complete in one large vol., imp. 8vo, with 111 Illustrations, 28s. [*Just published.*

JUKES DE STYRAP, M.K.Q.C.P., ETC.

Physician-Extraordinary, late Physician in Ordinary, to the Salop Infirmary; Consulting Physician to the South Salop and Montgomeryshire Infirmaries, etc.

THE MEDICO-CHIRURGICAL TARIFFS PREPARED FOR THE LATE SHROPSHIRE ETHICAL BRANCH OF THE BRITISH MEDICAL ASSOCIATION. Fourth Edition, fcap. 4to, revised and enlarged, 2s. *nett.*

C. W. SUCKLING, M.D. LOND., M.R.C.P.

Professor of Materia Medica and Therapeutics at the Queen's College, Physician to the Queen's Hospital, Birmingham, etc.

ON THE DIAGNOSIS OF DISEASES OF THE BRAIN, SPINAL CORD, AND NERVES. With Illustrations, crown 8vo, 8s. 6d.

JOHN BLAND SUTTON, F.R.C.S.

Lecturer on Comparative Anatomy, Senior Demonstrator of Anatomy, and Assistant Surgeon to the Middlesex Hospital; Erasmus Wilson Lecturer, Royal College of Surgeons, England.

LIGAMENTS: THEIR NATURE AND MORPHOLOGY. With numerous Illustrations, post 8vo, 4s. 6d.

HENRY R. SWANZY, A.M., M.B., F.R.C.S.I.

Examiner in Ophthalmic Surgery in the Royal University of Ireland, and to the Conjoint Board of the King and Queen's College of Physicians and Royal College of Surgeons, Ireland; Surgeon to the National Eye and Ear Infirmary, Dublin; Ophthalmic Surgeon to the Adelaide Hospital, Dublin.

A HANDBOOK OF THE DISEASES OF THE EYE AND THEIR TREATMENT. Second Edition, Illustrated with wood-engravings, colour tests, etc., small 8vo, 10s. 6d. [*Just published.*

EUGENE S. TALBOT, M.D., D.D.S.

Professor of Dental Surgery in the Woman's Medical College; Lecturer on Dental Pathology and Surgery in Rush Medical College, Chicago.

IRREGULARITIES OF THE TEETH AND THEIR TREATMENT. With 152 Illustrations, royal 8vo, 10s. 6d.

JOHN DAVIES THOMAS, M.D. LOND., F.R.C.S. ENG.

Physician to the Adelaide Hospital, S. Australia.

I.

HYDATID DISEASE, WITH SPECIAL REFERENCE TO ITS PREVALENCE IN AUSTRALIA. Demy 8vo, 10s. 6d.

II.

HYDATID DISEASE OF THE LUNGS. Demy 8vo, 2s.

HUGH OWEN THOMAS, M.R.C.S.

I.

DISEASES OF THE HIP, KNEE, AND ANKLE JOINTS, with their Deformities, treated by a new and efficient method. Third Edition, 8vo, 25s.

II.

CONTRIBUTIONS TO SURGERY AND MEDICINE:—

PART 1.—Intestinal Obstruction; with an Appendix on the Action of Remedies. 10s.

,, 2.—The Principles of the Treatment of Joint Disease, Inflammation, Anchylosis, Reduction of Joint Deformity, Bone Setting. 5s.

,, 3.—Fractures, Dislocations, Diseases and Deformities of the Bones of the Trunk and Upper Extremities. 10s.

,, 4.—The Collegian of 1666 and the Collegians of 1885; or what is recognised treatment? 2s. 6d.

,, 5.—On Fractures of the Lower Jaw. 1s.

,, 6.—The Principles of the Treatment of Fractures and Dislocations. 10s.

,, 8.—The Inhibition of Nerves by Drugs. Proof that Inhibitory Nerve-Fibres do not exist. 1s.

(Parts 7, 9 and 10 are in preparation).

J. ASHBURTON THOMPSON, M.R.C.S.

Late Surgeon at King's Cross to the Great Northern Railway Company.

FREE PHOSPHORUS IN MEDICINE WITH SPECIAL REFERENCE TO ITS USE IN NEURALGIA. A contribution to Materia Medica and Therapeutics. An account of the History, Pharmaceutical Preparations, Dose, Internal Administration, and Therapeutic uses of Phosphorus; with a Complete Bibliography of this subject, referring to nearly 200 works upon it. Demy 8vo, 7s. 6d.

J. C. THOROWGOOD, M.D.

Assistant Physician to the City of London Hospital for Diseases of the Chest.

THE CLIMATIC TREATMENT OF CONSUMPTION AND CHRONIC LUNG DISEASES. Third Edition, post 8vo, 3s 6d.

EDWARD T. TIBBITS, M.D. LOND.

Physician to the Bradford Infirmary; and to the Bradford Fever Hospital.

MEDICAL FASHIONS IN THE NINETEENTH CENTURY, including a Sketch of Bacterio-Mania and the Battle of the Bacilli. Crown 8vo, 2s. 6d.

H. H. TOOTH, M.A., M.D., M.R.C.P.

Assistant Demonstrator of Physiology at St. Bartholomew's Hospital.

THE PERONEAL TYPE OF PROGRESSIVE MUSCULAR ATROPHY. 8vo, 1s.

FREDERICK TREVES, F.R.C.S.

Hunterian Professor at the Royal College of Surgeons of England; Surgeon to and Lecturer on Anatomy at the London Hospital.

THE ANATOMY OF THE INTESTINAL CANAL AND PERITONEUM IN MAN. Hunterian Lectures, 1885. 4to, 2s. 6d.

D. HACK TUKE, M.D., LL.D.

Fellow of the Royal College of Physicians, London.

THE INSANE IN THE UNITED STATES AND CANADA. Demy 8vo, 7s. 6d.

LAURENCE TURNBULL, M.D., PH.G.
Aural Surgeon to Jefferson Medical College Hospital, &c., &c.

ARTIFICIAL ANÆSTHESIA: A Manual of Anæsthetic Agents, and their Employment in the Treatment of Disease. Second Edition, with Illustrations, crown 8vo, 6s.

DR. R. ULTZMANN.

ON STERILITY AND IMPOTENCE IN MAN. Translated from the German with notes and additions by ARTHUR COOPER, L.R.C.P., M.R.C.S., Surgeon to the Westminster General Dispensary. With Illustrations, fcap. 8vo, 2*s*. 6*d*.

W. H. VAN BUREN, M.D., LL.D.
Professor of Surgery in the Bellevue Hospital Medical College.

DISEASES OF THE RECTUM: And the Surgery of the Lower Bowel. Second Edition, with Illustrations, 8vo, 14s.

RUDOLPH VIRCHOW, M.D.
Professor in the University, and Member of the Academy of Sciences of Berlin, &c., &c.

INFECTION - DISEASES IN THE ARMY, Chiefly Wound Fever, Typhoid, Dysentery, and Diphtheria. Translated from the German by JOHN JAMES, M.B., F.R.C.S. Fcap. 8vo, 1s. 6d.

ALFRED VOGEL, M.D.
Professor of Clinical Medicine in the University of Dorpat, Russia.

A PRACTICAL TREATISE ON THE DISEASES OF CHILDREN. Third Edition, translated and edited by H. RAPHAEL, M.D., from the Eighth German Edition, illustrated by six lithographic Plates, part coloured, royal 8vo, 18s.

A. DUNBAR WALKER, M.D., C.M.

THE PARENT'S MEDICAL NOTE BOOK. Oblong post 8vo, cloth, 1s. 6d.

JOHN RICHARD WARDELL, M.D. EDIN., F.R.C.P. LOND.
Late Consulting Physician to the General Hospital Tunbridge Wells.

CONTRIBUTIONS TO PATHOLOGY AND THE PRACTICE OF MEDICINE. Medium 8vo, 21s.

W. SPENCER WATSON, F.R.C.S. ENG., B.M. LOND.
Surgeon to the Great Northern Hospital; Surgeon to the Royal South London Ophthalmic Hospital.

I.

DISEASES OF THE NOSE AND ITS ACCESSORY CAVITIES. Profusely Illustrated. Demy 8vo, 18s.

II.

EYEBALL-TENSION: Its Effects on the Sight and its Treatment. With woodcuts, p. 8vo, 2s. 6d.

III.

ON ABSCESS AND TUMOURS OF THE ORBIT. Post 8vo, 2s. 6d.

FRANCIS H. WELCH, F.R.C.S.
Surgeon Major, A.M.D.

ENTERIC FEVER: as Illustrated by Army Data at Home and Abroad, its Prevalence and Modifications, Ætiology, Pathology and Treatment. 8vo, 5s. 6d.

W. WYNN WESTCOTT, M.B.
Deputy Coroner for Central Middlesex.

SUICIDE; its History, Literature, Jurisprudence, and Prevention. Crown 8vo, 6s.

JOHN WILLIAMS, M.D., F.R.C.P.
Professor of Midwifery in University College, London; Obstetric Physician to University College Hospital; Physician Accoucheur to H.R.H. Princess Beatrice, etc.

CANCER OF THE UTERUS: Being the Harveian Lectures for 1886. Illustrated with Lithographic Plates, royal 8vo, 10s. 6d.
[*Just published.*

E. T. WILSON, B.M. OXON., F.R.C.P. LOND.
Physician to the Cheltenham General Hospital and Dispensary.

DISINFECTANTS AND HOW TO USE THEM. In Packets of one doz. price 1s.

DR. F. WINCKEL.

Formerly Professor and Director of the Gynæcological Clinic at the University of Rostock.

THE PATHOLOGY AND TREATMENT OF CHILD-BED: A Treatise for Physicians and Students. Translated from the Second German edition, with many additional notes by the Author, by J. R. CHADWICK, M.D. 8vo, 14s.

EDWARD WOAKES, M.D. LOND.

Senior Aural Surgeon and Lecturer on Aural Surgery at the London Hospital; Surgeon to the London Throat Hospital.

I.

ON DEAFNESS, GIDDINESS AND NOISES IN THE HEAD.

VOL. I.—POST-NASAL CATARRH, AND DISEASES OF THE NOSE CAUSING DEAFNESS. With Illustrations, cr. 8vo, 6s. 6d.

VOL. II.—ON DEAFNESS, GIDDINESS AND NOISES IN THE HEAD. Third Edition, with Illustrations, cr. 8vo. [*In preparation.*

II.

NASAL POLYPUS: WITH NEURALGIA, HAY-FEVER, AND ASTHMA, IN RELATION TO ETHMOIDITIS. With Illustrations, cr. 8vo, 4s. 6d. [*Now ready.*

DAVID YOUNG, M.C., M.B., M.D.

Licentiate of the Royal College of Physicians, Edinburgh; Licentiate of the Royal College of Surgeons, Edinburgh; Fellow of, and late Examiner in Midwifery to the University of Bombay; etc.

ROME IN WINTER AND THE TUSCAN HILLS IN SUMMER. A CONTRIBUTION TO THE CLIMATE OF ITALY. Small 8vo, 6s.

HERMANN VON ZEISSL, M.D.

Late Professor at the Imperial Royal University of Vienna.

OUTLINES OF THE PATHOLOGY AND TREATMENT OF SYPHILIS AND ALLIED VENEREAL DISEASES. Second Edition, revised by M. VON ZEISSL, M.D., Privat-Docent for Diseases of the Skin and Syphilis at the Imperial Royal University of Vienna. Translated, with Notes, by H. RAPHAEL, M.D., Attending Physician for Diseases of Genito-Urinary Organs and Syphilis, Bellevue Hospital, Out-Patient Department. Large 8vo, 18s. [*Just published.*

Clinical Charts For Temperature Observations, etc. Arranged by W. RIGDEN, M.R.C.S. 50s. per 1000, 28s. per 500, 15s. per 250, 7s. per 100, or 1s. per dozen.

Each Chart is arranged for four weeks, and is ruled at the back for making notes of cases; they are convenient in size, and are suitable both for hospital and private practice.

THE NEW SYDENHAM SOCIETY'S PUBLICATIONS.

President:—SIR SPENCER WELLS, BART., F.R.C.S.
Honorary Secretary:—JONATHAN HUTCHINSON, ESQ., F.R.S.
Treasurer:—W. SEDGWICK SAUNDERS, M.D., F.S.A.

Annual Subscription, One Guinea.

The Society issues translations of recent standard works by continental authors on subjects of general interest to the profession, and an Atlas of Pathology with Coloured Plates. The Society also has in hand a valuable and exhaustive "Lexicon of Medicine and the Allied Sciences."

Amongst works recently issued are "Spiegelberg's Midwifery," "Hirsch's Historical and Geographical Pathology," "Essays on Micro-Parasites," works by Charcot, Duchenne, Begbie, Billroth, Graves, Koch, Hebra, Guttmann, etc.

The Annual Report, with full list of works published, and all further information will be sent on application.

PERIODICAL WORKS PUBLISHED BY H. K. LEWIS.

THE NEW YORK MEDICAL JOURNAL. A Weekly Review of Medicine. Annual Subscription, One Guinea, post free.

THE THERAPEUTIC GAZETTE. A Monthly Journal, devoted to the Science of Pharmacology, and to the introduction of New Therapeutic Agents. Edited by Drs. H. C. Wood and R. M. Smith. Annual Subscription, 10s., post free.

THE GLASGOW MEDICAL JOURNAL. Published Monthly. Annual Subscription, 20s., post free. Single numbers, 2s. each.

LIVERPOOL MEDICO-CHIRURGICAL JOURNAL, including the Proceedings of the Liverpool Medical Institution. Published twice yearly, 3s. 6d. each number.

THE INDIAN MEDICAL JOURNAL. A Journal of Medical and Sanitary Science specially devoted to the Interests of the Medical Services. Annual Subscription, 24s., post free.

TRANSACTIONS OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA. Volumes I. to VI., 8vo, 10s. 6d. each.

MIDDLESEX HOSPITAL, REPORTS OF THE MEDICAL, SURGICAL, AND Pathological Registrars for 1883 to 1886. Demy 8vo, 2s. 6d. *nett* each volume.

*** MR. LEWIS is in constant communication with the leading publishing firms in America, and has transactions with them for the sale of his publications in that country. Advantageous arrangements are made in the interests of Authors for the publishing of their works in the United States.

Mr. Lewis's publications can be procured of all Booksellers in any part of the world.

London: Printed by H. K Lewis, 136 Gower Street, W.C.